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AB SPS-9A



Long-Term Pavement Performance

March 25, 1998
File: 800.12.13.1

Mr. Ron Stoski
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Twin Atria Bldg., 4999-98th Ave.
Edmonton, Alberta T6B 2X3
CANADA

RE: Final SPS-9A Construction Report

Dear Mr. Stoski:

Please find enclosed the final version of the LTPP SPS-9A Construction Report for the test site located on Highway 3 near Fort McLeod, Alberta. Addressed in the final report are all of the comments we received upon review of the draft.

We trust you will find this report adequate. If you have any questions, please do not hesitate to call.

Sincerely,
NICHOLS CONSULTING ENGINEERS, Chtd.

Douglas J. Frith, P.E.
Co-Principal Investigator

DJF/rkp
Enclosure

cc: Monte Symons
Gonzalo Rada
Shiraz Tayabji
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John Nichols, w/o encl.

FEDERAL HIGHWAY ADMINISTRATION
Long Term Pavement Performance Specific Pavement Studies

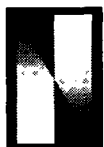
Fort Macleod, Alberta SPS-9A
Construction Report on SHRP 81A900

FINAL

prepared by:

Western Region Contractor
Nichols Consulting Engineers, Chtd.

March 1998



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INTRODUCTION

The SPS-9A experiment program is the first part of a multi-stage approach to validate the Strategic Highway Research Program's (SHRP) Superpave Asphalt Binder Study. Premature pavement failure due to numerous site specific variables is a common problem across the country. Most highway agencies have developed a standard asphalt paving mix which they use for most highway construction throughout the state/province. This study is designed to develop a method that will produce guidelines for pavement design that is site-specific, taking into account the traffic, environment, and pavement type. An asphalt pavement mix that utilizes site specific variables should decrease the risk of many premature pavement failures.

SPS-9A Objectives

The primary objectives of the Superpave Asphalt Binder Study experimentation are to:

- Evaluate and improve the practical aspects of implementing the Superpave program through hands-on field trials by highway agencies.
- Compare the performance of the Superpave mixes with mixes designed with current highway agency practices.
- Provide long-term performance data for evaluation and refinement of the Superpave specifications and design procedures.
- Test the sensitivity of the Superpave asphalt binder specifications for distress factors such as fatigue, low temperature cracking, and permanent deformation.
- Provide highway agencies the opportunity to evaluate the performance of other experimental modifications by the construction of supplemental sections.

The SPS-9A experiment requires construction of a minimum of three test sections at each site that will include the highway agencies' standard mix, the Superpave level 1 designed standard mix, and the Superpave mix with an alternative binder. The alternative binder is defined as a binder with a grade either higher or lower than the required Superpave binder such that the performance characteristics of interest may be expected to exhibit distresses earlier than the Superpave binder section. The pavement structure and thicknesses of layers containing the three experimental mixtures should be the same on all test sections.

Project Background

This report documents the construction of an SPS-9A project in Alberta, Canada, 81A900. Details of the construction are provided in the sections to follow. The project was a portion of an additional two lanes on Highway 3 near Fort Macleod, Alberta. The experimental project consists of three test sections, each constructed 500 meters in length on the newly built lanes. Construction of the surfacing on the test sections occurred November 21-22, 1995.

A Superpave PG graded binder, PG 52-34, was utilized on the Superpave section, a PG 46-34 was utilized on the alternate binder section and a 150/200A penetration grade binder was utilized on the agency standard mixture. A Superpave level 1 mixture design method was used on the Superpave sections, while the agency standard mixture was designed according to Marshall 75 blow mixture design. The alternate binder section, having a lower binder grading based upon the 7-day maximum air temperature, was chosen to evaluate the rutting potential of the mixture.

PROJECT DESCRIPTION

Figure 1 illustrates the location of the SPS-9A project. The project is located on the two newly constructed eastbound lanes of Highway 3, approximately 5 km east of Fort Macleod, Alberta. The test sections are located entirely on a shallow fill of native material. The subgrade is a fine grained clayey material. The terrain in the immediate area is mostly flat with a few drainage undulations.

Based upon the SHRPBIND program developed by LTPP and climatic data from nearby weather stations, the mean annual low air temperature is -35°C, the mean 7-day high air temperature is 31°C, the freezing index (C-Days) is 946 and the average annual precipitation is 391 mm. Thus, the site is classified as being in a dry-freeze climatic zone.

The designed pavement structure consists of 350 mm granular base and 120 mm of asphalt concrete placed in two equal lifts. Design traffic rates as reported by the Alberta Transportation and Utilities Department are:

| | |
|--|--------------------|
| Annual Average Daily Traffic (two directions) | 5280 |
| Percent Heavy Trucks and Combinations (of AADT) | 10.3 |
| Est. 18K ESAL Rate in Study Lane (1,000 ESAL/Year) | 146 |
| Total Design 18K ESAL Applications in Design Lane | 2.92×10^6 |
| Design Period (Years) | 20 |

Figure 2 indicates the layout of the test sections. Each test section was constructed 500m in length, without transitions between sections. All test sections were constructed between project stations 13+500 and 15+000. Section 81A901 was built from 14+000 to 14+500, section 81A902 between stations 13+500 to 14+000, and section 81A903 between 14+500 to 15+000. The actual monitoring portions of the test sections are located as illustrated figure 2 and documented in table 1.

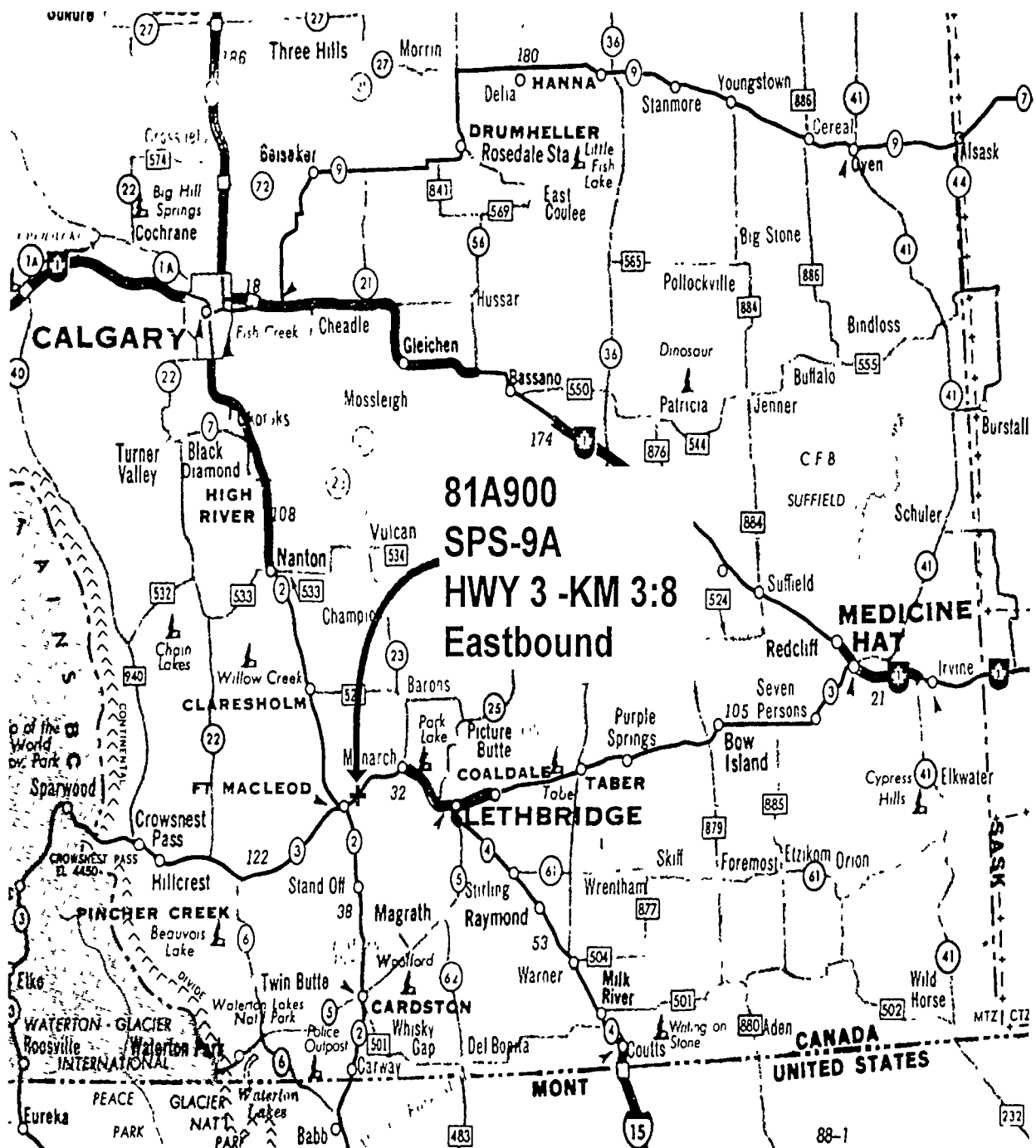


Figure 1. Location of Alberta SPS-9A project 81A900.

SPS-9 TEST SECTION LAYOUT
 81A900 – FORT MACLEOD, ALBERTA
 HIGHWAY 3 EASTBOUND
 08/20/97

EASTBOUND



4

| SUPERPAVE MIX DESIGN | | | | SUPERPAVE ALTERNATIVE BINDER | | | | AGENCY MIX DESIGN | | | |
|-------------------------|--------|----------|------|------------------------------------|--------|----------|------|----------------------|--------|----------|------|
| | SA | 81A902 | SA | | SA | 81A903 | SA | | SA | 81A901 | SA |
| feet | 246 | 500' | 246 | 566 | 246 | 500' | 246 | 730 | 246 | 500' | 246 |
| meters | 75.0 | 152.4 | 75.0 | 172.5 | 75.0 | 152.4 | 75.0 | 222.6 | 75.0 | 152.4 | 75.0 |
| | 13+675 | 13+827.4 | | | 14+150 | 14+302.4 | | | 14+675 | 14+827.4 | |

SA = SAMPLING AREA

Figure 2. SPS-9A (81A900) test section layout.

Table 1. Test section layout.

| Site | Location | Construction Stationing (m) | Test Section (ft) | Description |
|-------------------------------|---------------------|-----------------------------|-------------------|------------------------------|
| Transition 13+500 to 13+600 | | | | |
| 81A902 | Begin sampling area | 13+675 | -2-46 | Superpave Level 1 PG 52-34 |
| | Begin monitoring | 13+675 | 0+00 | |
| | End monitoring | 13+827.4 | 5+00 | |
| | End sampling area | 13+902.4 | 7+46 | |
| Transition 13+902.4 to 14+075 | | | | |
| 81A903 | Begin sampling area | 14+075 | -2-46 | Superpave Level 1 PG 46-34 |
| | Begin monitoring | 14+150 | 0+00 | |
| | End monitoring | 14+302.4 | 5+00 | |
| | End sampling area | 14+377.4 | 7+46 | |
| Transition 14+377.4 to 14+600 | | | | |
| 81A901 | Begin sampling area | 14+600 | -2-46 | Agency Standard 150/200A Pen |
| | Begin monitoring | 14+675 | 0+00 | |
| | End monitoring | 14+827.4 | 5+00 | |
| | End sampling area | 14+902.4 | 7+46 | |

CONSTRUCTION OPERATIONS

A summary of the complete paving operation is provided in this section of the report. Detailed below are the pre-paving operations, discussions regarding the AC mixture designs, summaries of the paving operation, and information concerning the additional materials sampling and testing performed on the test sections. The paving subcontractor on this job was South Rock Ltd from Medicine Hat, Alberta.

Mr. Jim Gavin, representing Alberta Transportation and Utilities, and Mr. Douglas Frith, representing Nichols Consulting Engineers and the LTPP Western Region, were on site during all Superpave paving operations. In addition, Alberta Transportation and Utilities had contracted with AGRA Engineering and Testing to collect and perform the Superpave tests. EBA Engineering was serving as the contractor's QC testing firm.

Pre-Paving Operations

Prior to the Western Region's involvement in the project, the earth work required for the construction of the embankment and base materials was completed. As previously mentioned, the embankment was comprised of local native material matching that of the subgrade. This material was classified as a fine grained clayey material. The embankment thickness varied from one to two meters in depth.

A 350mm thick crushed gravel base course was constructed directly on top of the embankment. The base course was compacted to 95 percent of the maximum proctor density. Prior to placement of the AC layers, the granular base course was primed. All embankment and base placement was completed between August and November 1997, which was prior to the Western Regional staff arriving on site.

Asphalt Concrete Mixture Designs

On this project, the mixture designs were the responsibility of the contractor. South Rock, Ltd had contracted with AGRA Earth and Environmental to perform all required mixture designs. Mixture designs consisted of a Superpave design having a 19.0mm nominal maximum aggregate size designed in accordance with Superpave Asphalt Mix Design specifications and Asphalt Institute Superpave Series No. 2 (SP 2). The second mixture design performed consisted of a Marshall mix design in accordance with Alberta Transportation and Utilities specification for Designation 1 Class 16, Type 2 Asphalt Concrete Mix.

Complete mixture designs for both mixes are provided in appendix A.

Superpave Mixture Design

Both sections 81A902 (Superpave) and 81A903 (Superpave with alternate binder) were designed based upon the level 1 Superpave volumetric mixture design procedures as referenced above. The actual mixture design was performed on section 81A902 and only the binder gradation changed for section 81A903, per the experimental guidelines.

The level 1 mixture design utilized the following number of gyrations, which were outlined in the Contract Special Provisions:

- N Initial (N_1) - 7
- N Design (N_d) - 86
- N Maximum (N_m) - 134

A Pine gyratory compactor was utilized for the mixture designs.

Aggregate for this mixture is comprised of coarse aggregate and manufactured fines from the Ft. Macleod East Government Pit and a washed concrete sand and a 10mm chip product obtained from the Hurlburt Pit. Mix design aggregates were blended as follows:

- 65 percent coarse aggregate
- 10 percent manufactured fine aggregate
- 20 percent 10mm chip
- 5 percent 5mm washed concrete sand

A blended gradation is provided in figure 3. As indicated, the gradation is on the coarse side of the curve and falls below the forbidden zone. Table 2 presents the mineral aggregate properties and the specification values.

Asphalt Concrete Combined Aggregate Gradations

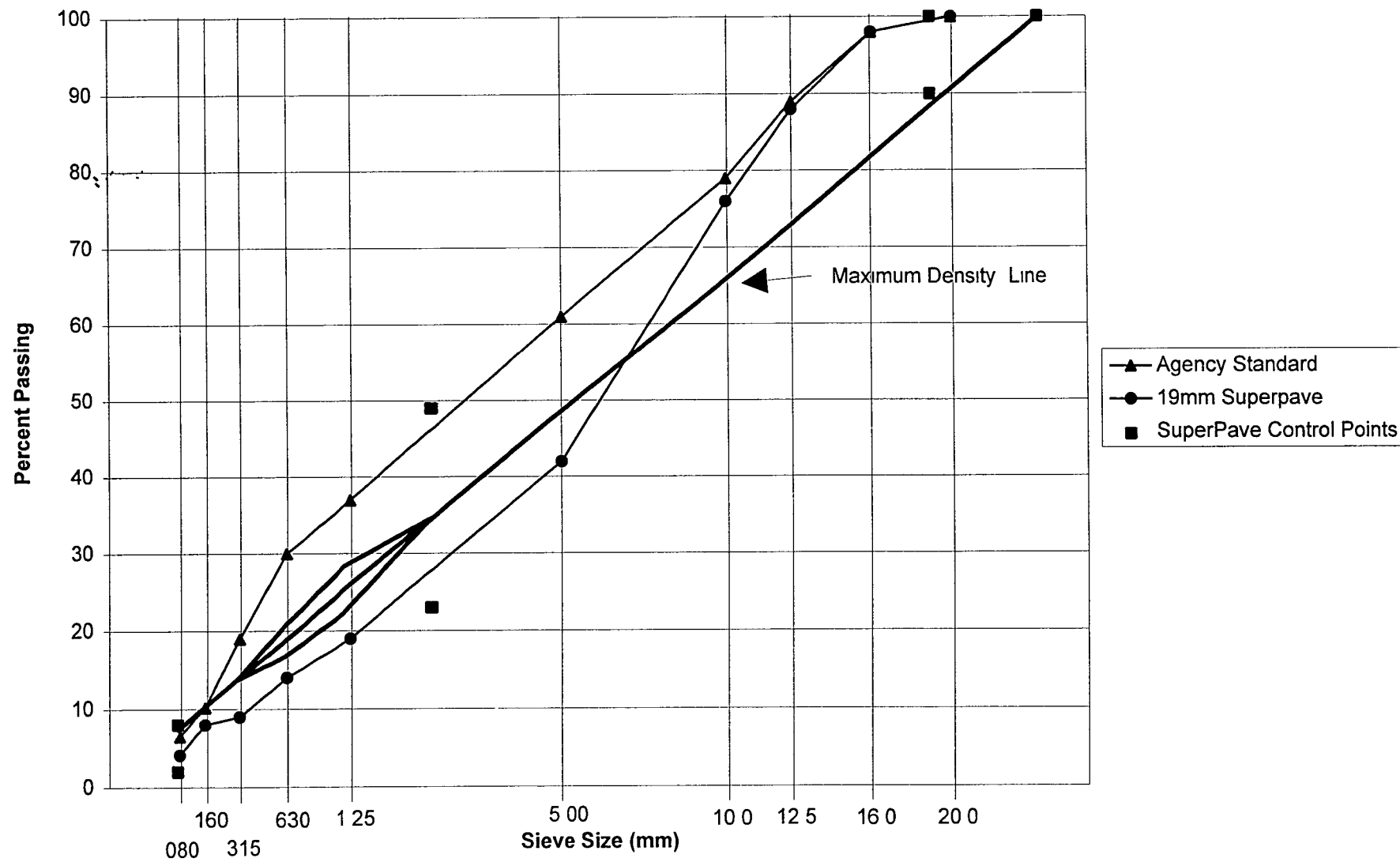


Figure 3. Combined Superpave aggregate gradation.

Table 2 Properties of combined mineral aggregate, Superpave mixture design.

| Mineral Aggregate Properties | | |
|--|--------|-------------|
| Property | Result | Criteria |
| Coarse Aggregate Angularity, % Fracture by Mass (ATT 50) | 94 | 75%, 1 Face |
| Fine Aggregate Angularity, % (TLT 125) | 43 | 40 Min. |
| Flat and Elongated Particles (ASTM D4791) | 2 6 | 10% Max. |
| Clay Content, % (AASHTO T176) | 59 | 40 Min. |
| Toughness, % Loss* (AASHTO T96) | 18.9 | 40 Max. |
| Deleterious Material* (TLT 107) | 1.8 | 3.0 Max |

*The reported value for Toughness (L.A Abrasion) Loss and Deleterious Material is for the coarse aggregate fraction which represents over 70 percent of the plus 5000 μm in the combined aggregate.

As mentioned, a Superpave performance graded binder (PG 52-34) was selected as the appropriate binder for this location, based upon a 98 percent reliability factor. The asphalt supplier was Husky Oil who supplied an asphalt meeting this specification, but which would normally be specified as a 200/300A penetration. In addition, the alternate binder test section utilized a Superpave performance graded binder (PG 46-34) meeting a typical 300/400A penetration specification. This asphalt was also supplied by Husky Oil.

A PG 52-34 asphalt cement at an asphalt content equal to 5 percent by weight of total mix (5.3 percent by weight of aggregate) was determined appropriate for this mixture design. Mixture properties based upon this aggregate and asphalt content are presented in table 3.

Table 3. Summary of Superpave mixture properties.

| Mixture Summary | | |
|------------------------------------|--------|-------------|
| Property | Result | Criteria |
| AC (By Mass of Total Mix) (%) | 5.0 | -- |
| AC (By Mass of Dry Agg) (%) | 5.3 | -- |
| Density (kg/m^3) | 2362 | -- |
| Air Voids (V_a) (%) | 4.1 | 4.0 |
| VMA (%) | 14.1 | 13.0 min. |
| VFA (%) | 71.5 | 65.0 - 78.0 |
| Dust Proportion | 1.0 | 0.6 - 1.2 |
| % Gmm @ Nini | 86.4 | < 89.0 |
| % Gmm @ Nmax | 97.3 | < 98.0 |
| Average Dry Strength (kPa) | 360 | -- |
| Tensile Strength Ratio (%) | 92 | 80 min. |
| Average Gse Blend (Gse) | 2.681 | -- |
| Sp. Gravity of Binder (Gb) | 1.030 | -- |
| Sp. Gravity of Aggregate (Gsb) | 2.612 | -- |
| Film Thickness (μm) | 10.97 | -- |

Agency Standard Mixture Design

Section 81A901 (Agency Standard) was designed following the standard practices of Alberta Transportation and Utilities: a Marshall Method of Mix Design as outlined in the latest edition of the Asphalt Institute Manual Series No. 2 (MS-2) and ASTM D 1559 (75 blow).

This test section was meant to serve as a control section and represent standard mixtures, materials, and construction practices typically utilized for highway construction in Alberta.

Aggregate for this mixture is comprised of coarse aggregate, manufactured fines, and blend sand from the Ft. Macleod East Government Pit and a blend sand from the McCollough Pit. Mix design aggregates were blended as follows:

- 60 percent coarse aggregate
- 22 percent manufactured fine aggregate
- 9 percent blend sand, Ft. Mcleod East Pit
- 9 percent blend sand, McCollough Pit

A blended gradation is provided in figure 3 in conjunction with the Superpaave gradation. Table 4 presents the mineral aggregate properties and the specification values.

Table 4. Properties of combined mineral aggregate, agency standard mixture design

| Mineral Aggregate Properties | | |
|--|-------------|-------------|
| Property | Result | Criteria |
| Coarse Aggregate Angularity, % Fracture by Mass (ATT 50) | 94 | 70%, 1 Face |
| % Manufactured Fines (-5000 μm) | 70.4 | 70% |
| Plasticity Index | Non-Plastic | -- |
| Toughness, % Loss* (AASHTO T96) | 18.9 | 40 Max. |
| Deleterious Material* (TLT 107) | 1.8 | 3.0 Max |

*The reported value for Toughness (L.A. Abrasion) Loss and Deleterious Material is for the coarse aggregate fraction which represents over 70 percent of the plus 5000 μm in the combined aggregate.

A penetration grade 150/200A asphalt cement supplied is the common asphalt grade required for this location and highway in Alberta. Husky Oil provided the asphalt cement for this mixture as well.

A 150/200A asphalt cement at an asphalt content equal to 5.2 percent by weight of total mix (5.5 percent by weight of aggregate) was determined appropriate for this mixture design. Mixture properties based upon this aggregate and asphalt content are presented in table 5.

Table 5. Summary of agency standard Marshall mixture properties.

| Marshall Property | Mix Design Results | Specifications |
|------------------------------------|--------------------|----------------|
| A.C. Content (% dry wt. agg.) | 5.5 | -- |
| Density (kg/m^3) | 2368 | -- |
| Marshall Stability (kN) | 15.8 | 12.0 min. |
| Flow (mm) | 2.9 | 2.0 to 3.5 |
| Air Void (%) | 3.9 | 3 to 5 |
| V.M.A. (%) | 14.2 | 13.5 |
| Film Thickness (μm) | 6.9 | -- |
| Voids Filled (%) | 73 | 65 - 75 % |
| Retained Stability (%) | 96 | 70 min. |
| F/A Ratio | 1.5 | -- |

Paving Operation

The asphalt concrete surfacing was paved within the test sections November 21 and 22, 1995. Paving had progressed on the job up to the SPS-9A test sections, at which time they were completed. Upon completion of the test sections, the contractor resumed typical paving operations for the remainder of the job.

Detailed in this section of the report are the hot-mix plant, the paving equipment utilized and the paving sequencing used to complete the operation. Normal paving equipment and techniques were utilized in the completion of these test sections.

Hot-Mix Plant

All asphalt concrete was produced from one hot plant. The hot plant was located near the junction of Highway 3 and Highway 2 on the east side of Fort Macleod. Therefore, the haul distance for the asphalt concrete was approximately 6 km. A CMI dryer-drum portable hot plant was erected in the Ft. Macleod East Government Pit, the source of the majority of aggregate.

A dryer-drum plant was utilized and a production rate of approximately 500 tonnes/hour was routinely produced. Samples of the aggregate combination and the asphalt cement were collected at the hot plant during production.

Paving Equipment

Two different paving trains were utilized within the test sections. Paving train number one completed the lay down of all asphalt concrete in the right hand (travel) lane and outside shoulder, including both the top and bottom lifts. Paving train number 2 completed the paving in the left hand (passing) lane and the inside shoulder. Listed in table 6 are the equipment of which each paving train was comprised.

Table 6. Equipment used during asphalt concrete placement

| Equipment Type | Paving Train #1 Description | Paving Train #2 Description |
|-----------------------|--|---|
| Haul Trucks | End Dumps (Tarped) | End Dumps (Tarped) |
| Transfer Box | Modified Blaw-Knox PF-200B Paver | Modified Blaw-Knox Paver |
| Paver | Blaw-Knox PF-220 (Rubber Tire) | Blaw-Knox PF-220 (Rubber Tire) |
| Breakdown Roller | DynaPac CC-501 Double Steel Drum Vibrating | Catipillar CB-634 Double Steel Drum Vibrating |
| Intermediate Roller | DynaPac CP-30 Pneumatic Rubber Tired | DynaPac CP-30 Pneumatic Rubber Tired |
| Finish Roller | Bowmag BW 202 ADH Double Steel Drum | DynaPac CC-42 Double Steel Drum |

During paving, the finish grade was controlled using electronic grade controls. A rigid bridge-type ski, extending 11m ahead of the screed and 7m behind the screed was attached to the paver. The ski behind the screed rode on the hot mat. The electronic grade controls then operated off of this ski.

Paving Sequencing

As mentioned, two paving trains were operated during the construction of the test sections. Also, paving of the entire test area was completed November 21 and 22, 1995. Paving began at the west end of the test sections in all cases and progressed eastwardly.

The actual lay down of the hot mixed asphalt concrete was very similar with both paving trains. In some instances, the number of rollers or rolling patterns varied slightly, which is documented in the Detailed Construction Notes portion of this report. Lay down consisted of delivery of the asphalt concrete to the site in large end dump tractor-trailers, which were covered with a tarp to retain as much heat as possible. The haul distance from the plant to the test sections was between 5 and 6 km. The end dump transferred the asphalt concrete into a modified older paver, which was utilized as a transfer device. This modified paver consisted of the original hopper and conveyor belts but was then modified so that the asphalt concrete was augured onto a large conveyor belt that extended from the back of the paver upward. Material from this large conveyor belt would then drop into the hopper on the paver. Utilizing this transfer device allowed the hopper on the paver to remain at a nearly constant level, while maintaining a constant speed. This device also ensured the end dumps would not bump the paving machine and cause unnecessary roughness in the roadway.

The rubber tired paver then utilized a heated vibrating screed to strike off the asphalt concrete. Three passes were completed by the double steel drum breakdown roller, one of which was vibrated. In most cases, the breakdown roller was immediately behind the paver. Eight passes were then made with the pneumatic roller. Finish rolling was completed with a double steel drum static roller. The finish roller made numerous passes, depending upon the speed of the paver and the roller marks remaining in the mat.

Paver number two, utilized only in the passing lane, produced a strip of segregated material approximately 0.2m wide, occurring 0.9m left of the right edge of the mat. This segregation was evident throughout the length of paving. Other isolated areas of segregation occurred within the test sections, which are identified in the Detailed Paving Notes portion of this report.

All three sections were paved in two lifts, both lifts having the same mixture design. Each lift was designed to be placed 75mm loose thickness, compacting to 60mm in depth. The longitudinal joint between lifts was offset 75mm to the right of centerline.

The paving sequence used for the two days of test section paving is illustrated in table 7. November 21, 1995, paving began on the first lift using paving train one on the travel lane of section 81A902 laying the Superpave mixture. Paving began at 7:45 a.m. under clear skies and an air temperature of 5°C. Upon completion of the entire 500 meter test strip, the paver was cleaned out and prepared for the next section. Approximately one hour after paving train one started, paving train two began paving the first lift of the adjacent (passing) lane. At the completion of this lift, paver two was cleaned out as well. The asphalt plant shut down after

Table 7 Test section paving sequencing

| Time | Paving Train #1 | | | Paving Train #2 | | |
|-----------|-----------------|--------|--------|-----------------|--------|---------|
| | Section | Lift | Lane | Section | Lift | Lane |
| 21-Nov-95 | | | | | | |
| 730 | | | | | | |
| 800 | 81A902 | Bottom | Travel | | | |
| 830 | | | | | | |
| 900 | | | | 81A902 | Bottom | Passing |
| 930 | | | | | | |
| 1000 | | | | | | |
| 1030 | | | | | | |
| 1100 | | | | | | |
| 1130 | | | | | | |
| 1200 | 81A903 | Bottom | Travel | | | |
| 1230 | | | | | | |
| 1300 | | | | 81A903 | Bottom | Passing |
| 1330 | | | | | | |
| 1400 | | | | | | |
| 1430 | 81A903 | Top | Travel | | | |
| 1500 | | | | | | |
| 1530 | | | | 81A903 | Top | Passing |
| 1600 | | | | | | |
| 1630 | | | | | | |
| 1700 | | | | | | |
| 1730 | | | | | | |
| 1800 | 81A902 | Top | Travel | | | |
| 1830 | | | | | | |
| 1900 | | | | 81A902 | Top | Passing |
| 1930 | | | | | | |
| 22-Nov-95 | | | | | | |
| 730 | | | | | | |
| 800 | 81A901 | Bottom | Travel | | | |
| 830 | | | | | | |
| 900 | | | | 81A901 | Bottom | Passing |
| 930 | | | | | | |
| 1000 | | | | | | |
| 1030 | | | | | | |
| 1100 | 81A901 | Top | Travel | | | |
| 1130 | | | | | | |
| 1200 | | | | 81A901 | Top | Passing |
| 1230 | | | | | | |
| 1300 | | | | | | |

production of the Superpave material, switched asphalt supply tanks and prepared for the production of the alternate binder Superpave material.

Paving train one began placing the alternate binder Superpave mixture as the first lift on section 81A903 in the travel lane. Approximately one hour after paving train one began, paving train two began laying the first lift of the passing lane. Upon completion of the first lift in this section, both paving trains returned to the beginning of the section and repeated the operation for the alternate binder mixture. Paving in this sequence allowed the hot plant to continue production of the alternate binder mixture. Once the final lift was placed on both lanes within this section, both pavers were cleaned out and the paving trains retreated to the beginning of section 81A902.

The final lift of section 81A902 was completed using artificial lighting on November 21, 1995. The paving sequence was the same as the first lift, that is, paving train one was utilized for the travel lane and paving train two laid the passing lane. Paving was completed at 6:50 p.m. with an air temperature equal to -1°C .

Both lifts of the agency standard mixture on section 81A901 were placed November 22, 1995. This day, the weather was less desirable as the air temperature was -3°C initially with overcast skies and the threat of snow flurries. Paving began on the travel lane at 7:45 a.m. utilizing paving train one. Paving train two began placing the first lift on the passing lane at 8:40 a.m.

Upon completion of the first lift, both paving trains returned to the beginning of this test section and constructed the second lift in the same manner as the first was constructed. Paving began on the travel lane at 10:35 a.m. and was completed at 12:05 p.m. Ambient air temperature at the completion of the second lift was 0°C .

Material Sampling and Testing

Numerous samples were collected during construction. Many samples were collected by the contractor for quality control purposes, other samples were collected by Alberta Transportation and Utilities for quality assurance purposes and still others were collected solely for experimental testing purposes. The sampling and testing described in this section pertains only to those additional samples that were required for the SPS-9 testing.

Provided in table 8 is a summary of the types and quantities of samples collected from each test section during construction. Many of these samples were tested immediately, others were molded and tested at a later date and others have been stored for future testing. Once all Superpave testing equipment and procedures have been developed, these stored samples will then be tested.

Table 8. Additional material samples collected during construction for SPS-9 specified testing.

| Test Section | 81A901 | 89A902 | 81A903 |
|--|--|--|--|
| Bulk Lab HMA Mix (Performance Tests) | -- | 300 kg mix in lab, compact into 34 specimens | -- |
| Bulk HMA Mix During Placement (QC Tests) | 60 kg - molded in gyratory (6 samples) | 60 kg - molded in gyratory (6 samples) | 60 kg - molded in gyratory (6 samples) |
| Bulk Field HMA Mix (Performance Tests) | -- | 360 kg mix - compact into 36 specimens | -- |
| Asphalt Cement | One 10 liter pail | One 10 liter pail | One 10 liter pail |
| Aggregate | Ten 25 kg samples | Ten 25 kg samples | Ten 25 kg samples |
| MRL Asphalt Cement | One 20 liter pail | One 20 liter pail | One 20 liter pail |
| MRL Aggregates | Ten 20 liter pails | Ten 20 liter pails | -- |
| 150mm Cores Immediately After Construction | 8 cores | 34 cores | 8 cores |

The required material tests can be divided into five categories, 1) Material Verification, 2) Mixture Design Conformation, 3) Quality Control Tests, 4) As-Built Tests, and 5) Performance Prediction Tests. Each category is further divided into multiple individual tests. Tables 9-13 provide a listing of the tests required. A comparison of the mixture design values and the as-built values are provided in table 14.

DETAILED CONSTRUCTION NOTES

During paving, NCE staff were on-site to collect detailed construction notes. The purpose was not to serve as inspectors, but rather to document the operations. All inspection and acceptance was the responsibility of Alberta Transportation and Utilities personnel.

Typical information recorded during paving included weather conditions, air temperature, mat temperature, equipment, methods, materials and uncompacted thickness measurements. Generally, the uncompacted thickness measurements were recorded using a metal rod, which was pushed through the paving mat immediately behind the paver, then the depth of rod penetration was recorded. Due to the paving sequencing (i.e., two paving trains) measurements were only recorded for the travel lane, and each of these measurements was taken near the centerline edge of the paving pass. Pavement mat temperatures were recorded using a hand-held infrared thermometer.

Documented below are the details of the construction operation on each of the three experimental sections. Detailed construction notes are provided in appendix B.

Section 81A901 - Agency Standard Mixture

Paving of this section began on November 22, 1995. Both lifts were completed this date. Detailed notes were recorded on the travel lane, although only limited information was recorded for the passing lane. A visual comparison of this mixture and the Superpave mixtures showed this mixture to be much finer. This mixture also appeared drier (more brown than black), although it did not look too dry. A tack coat was applied to the primed base material and again between lifts.

Table 9. Material verification tests

| Test Name | Test Designation | Test Protocol |
|--|------------------|-----------------|
| Aggregate Tests | | |
| Aggregate Gradation | AG04 | LTPP P14 |
| Specific Gravity of Coarse Aggregate | AG01 | LTPP P11 |
| Specific Gravity of Fine Aggregate | AG02 | LTPP P12 |
| Specific Gravity of -200 material | -- | AASHTO T100 |
| Coarse Aggregate Angularity | -- | Penn DOT TM 621 |
| Fine Aggregate Angularity | -- | ASTM C1252 |
| Toughness | -- | AASHTO T96 |
| Soundness | -- | AASHTO T104 |
| Deleterious Materials | -- | AASHTO 112 |
| Clay Content | -- | AASHTO T176 |
| Thin, Elongated Particles | -- | ASTM D 4791 |
| Asphalt Cement | | |
| Penetration @ 5°C | -- | AASHTO T49 |
| Penetration @ 25° & 46°C | AE02 | LTPP P22 |
| Viscosity @ 60° & 135°C | AE05 | LTPP P25 |
| Specific Gravity @ 16°C | AE03 | LTPP P23 |
| Dynamic Shear @ 3 Temperatures | -- | AASHTO TP5 |
| Brookfield Viscosity @ 135° & 165°C | -- | ASTM D4402 |
| Rolling Thin Film Oven (RTFOT) | -- | AASHTO T240 |
| Dynamic Shear on RTFOT Residue @ 3 Temperatures | -- | AASHTO TP5 |
| Pressure Aging (PAV) of RTFOT Residue | -- | AASHTO PP1 |
| Creep Stiffness of RTFOT-PAV Residue @ 2 Temperatures - 24h conditioning | -- | AASHTO TP1 |
| Creep Stiffness of RTFOT-PAV Residue @ 2 Temperatures | -- | AASHTO TP1 |
| Dynamic Shear on RTFOT-PAV Residue @ 3 Temperatures | -- | AASHTO TP5 |
| Direct Tension on RTFOT-PAV Residue @ 2 Temperatures | -- | AASHTO TP3 |

Table 10. Mixture design conformation tests.

| Test Name | Test Designation | Test Protocol |
|--|------------------|---------------|
| Mixed and Compacted HMA | | |
| Gyratory Comp. @ Design Asphalt Content at N_{max} | -- | AASHTO M-002 |
| Gyratory Comp. @ 3% AV(lab samples) | -- | AASHTO M-002 |
| Gyratory Comp. @ 7% Air Voids | -- | AASHTO M-002 |
| Bulk Specific Gravity | AC02 | LTPP P02 |
| Maximum Specific Gravity | AC03 | LTPP P03 |
| Asphalt Content (Extraction) (Uncomp. Material) | AC04 | LTPP P04 |
| Aggregate Gradation (Extracted Aggregate) | AG04 | LTPP P14 |
| Moisture Susceptibility | AC05 | LTPP P05 |
| Volumetric Calculations | | |
| Volume Percent of Air Voids | -- | AASHTO PP19 |
| Percent Voids in Mineral Aggregate | -- | AASHTO PP19 |
| Voids Filled with Asphalt | -- | AASHTO PP19 |

Table 11. During placement non-standard quality control tests

| Test Name | Test Designation | Test Protocol |
|---|------------------|---------------|
| HMA Specimen Compaction | | |
| Gyratory Comp. @ N_{max} | -- | AASHTO M-002 |
| Volumetric Tests | | |
| Bulk Specific Gravity | AC02 | LTPP P02 |
| Asphalt Content (Extraction) | AC04 | LTPP P04 |
| Aggregate Gradation (Extracted Aggregate) | AG04 | LTPP P14 |
| Maximum Specific Gravity | AC03 | LTPP P03 |
| Volumetric Calculations | | |
| Volume Percent of Air Voids | -- | AASHTO PP19 |
| Percent Voids in Mineral Aggregate | -- | AASHTO PP19 |
| Voids Filled with Asphalt | -- | AASHTO PP19 |

Table 12 As-built material tests from cores

| Test Name | Test Designation | Test Protocol |
|---|------------------|---------------|
| Core Examination/Thickness | AC01 | LTPP P01 |
| Volumetric Analysis | | |
| Bulk Specific Gravity | AC02 | LTPP P02 |
| Asphalt Content (Extraction) | AC04 | LTPP P04 |
| Aggregate Gradation (Extracted Aggregate) | AG04 | LTPP P14 |
| Volumetric Calculations | | |
| Volume Percent of Air Voids | -- | AASHTO PP19 |
| Percent Voids in Mineral Aggregate | -- | AASHTO PP19 |
| Voids Filled with Asphalt | -- | AASHTO PP19 |
| Recovered Asphalt Cement | | |
| Abson Recovery | AE01 | LTPP P21 |
| Penetration @ 5°C | -- | AASHTO T49 |
| Penetration @ 25° & 46°C | AE02 | LTPP P22 |
| Viscosity @ 60° & 135°C | AE05 | LTPP P25 |
| Specific Gravity @ 16°C | AE03 | LTPP P23 |
| Dynamic Shear @ 3 Temperatures | -- | AASHTO TP5 |
| Creep Stiffness @ 2 Temperatures | -- | AASHTO TP1 |
| Direct Tension @ 2 Temperatures | -- | AASHTO TP3 |

Table 13. Performance prediction tests to be performed by
Superpave Regional Test Center.

| Test Name | Test Designation | Test Protocol |
|--|------------------|---------------------|
| LTPP Performance Tests by LTPP Contract Laboratory | | |
| Indirect Tensile Strength | AC07 | LTPP P07 |
| Resilient Modulus | AC07 | LTPP P07 |
| Creep Compliance | AC06 | LTPP P06 |
| Superpave Shear Tester Performance Tests by Superpave Regional Test Center | | |
| Frequency Sweep at Constant Height & Simple Shear at Constant Height | SST-1 | AASHTO M-003, P-005 |
| Volumetric Test & Uniaxial Strain | SST-2 | AASHTO M-003, P-005 |
| Repeated Shear at Constant Stress Ratio | SST-3 | AASHTO M-003, P-005 |
| Superpave Indirect Tensile Tests by Superpave Regional Test Center | | |
| Indirect Tensile Creep Compliance & Indirect Tensile Strength | SP-IT | AASHTO M-005 |

Table 14. Comparison of design and as-built mixture properties.

| Material Property | 81A901 | | 81A902 | | 81A903 | |
|--------------------------------|--------|--------|--------|--------|--------|--------|
| | Design | Actual | Design | Actual | Design | Actual |
| Air Voids (%) | 3.9 | 5.7 | 4.1 | 8.2 | 4.1 | 8.4 |
| Voids in Mineral Aggregate (%) | 14.2 | 15.1 | 14.1 | 16.9 | 14.1 | 17.3 |
| Voids Filled with Asphalt (%) | 73 | 62.4 | 71.5 | 51.9 | 71.5 | 51.8 |
| Asphalt Content (%) | 5.5 | 5.2 | 5.0 | 4.9 | 5.0 | 5.1 |
| Thickness (mm) | 120 | 126.3 | 120 | 120.8 | 120 | 119.3 |
| Gradation (Metric Sieves) | | | | | | |
| 160mm | 98 | 98 | 98 | 98 | 98 | 99 |
| 12.5mm | 89 | 89 | 88 | 88 | 88 | 92 |
| 10mm | 79 | 80 | 76 | 78 | 76 | 82 |
| 5mm | 61 | 60 | 42 | 44 | 42 | 48 |
| 2.5mm | -- | 46 | -- | 28 | -- | 32 |
| 1.25mm | 37 | 36 | 19 | 20 | 19 | 22 |
| 0.630mm | 30 | 30 | 14 | 16 | 14 | 17 |
| 0.315mm | 19 | 20 | 9 | 12 | 9 | 12 |
| 0.160mm | 10.2 | 11.4 | 8.0 | 7.8 | 8.0 | 8.4 |
| 0.080mm | 6.5 | 7.7 | 4.1 | 5.6 | 4.1 | 6.1 |

The bottom lift was placed between 7:45 a.m. and 9:50 a.m.. During this time period the ambient air temperature increased from -3°C to -1°C, and snow flurries were reported for a short duration. The paving equipment and methods were as previously discussed. This lift had an average uncompacted thickness of 77mm and an average behind the paver mat surface temperature of 150°C. Near the end of the section, station 14+825 onward, the paver had to routinely stop while waiting for trucks to arrive. When the paver was stopped for this reason, the transfer box was emptied of asphalt concrete, although the paver kept a full hopper of material. Samples, used both for the SPS study and for routine quality control, were collected near station 14+720.

The top lift was constructed the same day as the lower lift between 10:35 a.m. and 12:05 p.m. As noted, a tack coat was placed between the two lifts. The air temperature during this paving was also very cool. The ambient air temperature at the beginning was -1°C and was 0°C when completed. The paving operation utilized the same equipment (paving train one) and sequencing as before with the exception of a fourth roller added to the paving train. An additional double steel drum roller was utilized between the pneumatic and the finish roller. The average uncompacted thickness through this lift was 79mm and the mat temperature was 138°C. Two areas of segregation were noted during construction. A small area near station 14+690 was very coarse and shovels of hot-mix were spread and raked to repair the area. A larger area of segregation near the middle of the lane was evident in the middle of the mat near station 14+950. This area was also repaired by hand.

Section 81A902 - Superpave Level 1 Mixture

Paving of this section began on November 21, 1995. Both lifts were completed this date. Detailed notes were recorded on the travel lane, although only limited information was recorded for the passing lane. The general opinion of Alberta Transportation and Utilities and contractor personnel was that the Superpave mixture was much coarser with more asphalt than their standard mixes. Initially, many of the contractor personnel thought the Superpave mix was segregating, but they soon realized it was simply a coarser gradation than they were used to seeing. Contractor personnel did not think the Superpave mixes were any different to work with other than they were more difficult to rake. As with the agency standard section, a tack coat was applied to the primed base material and again between lifts. No tack coat was applied between lifts on the passing lane.

The bottom lift was placed between 7:45 a.m. and 9:30 a.m.. At the beginning of paving, the ambient air temperature was 5°C and gradually increased as the weather was clear and sunny. The paving equipment and methods were as previously discussed. This lift had an average uncompacted thickness of 73mm and an average behind the paver mat surface temperature of 120°C. The paver was stopped near station 13+750 for approximately 40 minutes while being repaired. No cold joint was placed as the paver was not moved for the repair. The paver was again stopped for about 10 minutes near station 13+920 while waiting on the delivery trucks. Samples, used both for the SPS study and for routine quality control, were collected near station 13+825. At one point, the internal mat temperature was measured to be 142°C, which was approximately 15°C higher than the surface temperature measured concurrently.

The top lift was constructed late the same day as the lower lift, between 5:25 p.m. and 6:50 p.m. Paving was performed using artificial lighting. As noted, a tack coat was placed between the two lifts. The air temperature had decreased during the day and had substantially reduced as nightfall approached. The ambient air temperature was measured as 1°C as paving began and -1°C when paving was completed. The paving operation utilized the same equipment (paving train one) and sequencing discussed in the equipment portion of the report. The average uncompacted thickness through this lift was 76mm and the mat temperature was 136°C.

Section 81A903 - Superpave Level 1 Mixture with Alternate Binder

Paving of this section began on November 21, 1995. Both lifts were completed this date. Detailed notes were recorded on the travel lane, although only limited information was recorded for the passing lane. This mixture looked identical to that placed in section 81A902. As with the other two sections, a tack coat was applied to the primed base material and again between lifts. No tack coat was applied between lifts on the passing lane.

The bottom lift was placed between 11:27 a.m. and 1:15 p.m. At the beginning of paving, the ambient air temperature was 9°C and the skies were partly cloudy. The paving equipment and methods were as previously discussed. This lift had an average uncompacted thickness of 79mm and an average behind the paver mat surface temperature of 124°C. The paver was stopped several times near the end of the section (station 14+355 onward) for as much as 7 minutes while waiting for material to be delivered. Samples, used both for the SPS study and for routine quality control were collected near station 14+150. At one point, the internal mat temperature was measured to be 134°C, which was approximately 10°C higher than the surface temperature measured concurrently.

The top lift was constructed immediately following completion of the first lift. Paving occurred between 2:00 p.m. and 3:15 p.m. As noted, a tack coat was placed between the two lifts. The air temperature decreased from 8°C to 6°C as paving progressed. The paving operation utilized the same equipment (paving train one) and sequencing discussed in the equipment portion of the report. The average uncompacted thickness through this lift was 76mm and the mat temperature was 122°C. Twice the paver began slipping on the tack coat; once near station 14+105 when the paver had to be pulled with a blade and again at station 14+400.

SUMMARY

Three 500m test sections were constructed November 21-22, 1995 conforming to the requirements of the LTPP SPS-9A experimental guidelines. The three test sections were included in the newly constructed eastbound lanes of Highway 3 just east of Fort Macleod, Alberta. The pavement structure consisted of 120mm of asphalt concrete placed on 350mm of a crushed granular base course over 1 to 2m of a fine grained clayey fill material.

All test sections are located between project stations 13+500 and 15+000. Superpave level 1 mixture design criteria were utilized to design two of the three sections. The agency standard section was designed using the Marshall 75 blow mixture design method. Asphalt binder in each of the three sections varied. A performance graded binder, PG 52-34 was utilized on the Superpave section, a PG 46-34 was used in the alternate binder section and a 150/200A penetration grade asphalt cement was used in the agency standard section.

Typical construction practices were utilized throughout the project and no deviations from the experimental guidelines were evident. The air temperature during placement was between 0°C and 9°C on November 21 and between -3°C and 0°C on November 22. No measurable precipitation was received during placement.

Post construction testing revealed the final thicknesses were nearly identical between all three sections and matched the design thickness. Also, gradations and asphalt contents were very near the design values. Both Superpave mixtures seem to have been placed with greater air voids (8 percent) than as designed (4 percent). This resulted in a greater voids in mineral aggregate (VMA) as well as a lower voids filled with asphalt (VFA) than designed. These values should change as initial densification due to traffic is expected.

No major deficiencies, either due to materials or construction, were identified. Therefore, this project should prove to be an excellent experiment in meeting the SPS-9A experimental objectives.

APPENDIX A

MIXTURE DESIGNS



AGRA Earth &
Environmental Limited
221 - 18th Street SE
Calgary, Alberta
Canada T2E 6J5
Tel (403) 248-4331
Fax (403) 248-2188

CA-12139
30 October 1995

South Rock Limited
P.O. Box 460
Medicine Hat, Alberta
T1A 7G2

Attention: Mr. R.W. Forfylow, P.Eng.

Dear Sir:

RE: HIGHWAY 3:08 SUPERPAVE LEVEL I ASPHALT MIX DESIGN
CONTRACT #5519/94

As per your request, AGRA Earth & Environmental Limited (AEE) has performed a Level I, 19.0 mm nominal maximum size mix design in accordance with Superpave Asphalt Mix Design specifications and Asphalt Institute Superpave Series No.2 (SP 2).

The number of gyrations used in the design, as outlined in the Contract Special Provisions, were:

| | |
|----------------|-----|
| N Initial (Ni) | 7 |
| N Design (Nd) | 86 |
| N Maximum (Nm) | 134 |

The average submitted stockpile gradations of the coarse aggregate and manufactured fines from the Ft. Macleod East Pit, as well as a washed concrete sand and a 10 mm Chip product obtained from the Hurlburt Pit are presented as samples No.1 through No.4, attached. Using these submitted gradations, the mix aggregates were blended as follows:

| | |
|----|-------------------------------------|
| 65 | percent coarse aggregate |
| 10 | percent manufactured fine aggregate |
| 20 | percent 10 mm Chip |
| 5 | percent 5 mm washed concrete sand |

The results of this combined grading are presented in the attached sieve analysis identified as Sample No. 5, Lab Blend.

Preparation of the asphalt mix samples was in accordance with the Superpave Method of Mix Design as outlined in the latest edition of the Asphalt Institute Manual "Superpave Level 1 Asphalt Mix Design" incorporating Husky Oil Ltd. 150/200A penetration grade asphalt cement and aggregates combined as noted above.

At an asphalt binder content of 5.3 percent (by mass of dry aggregate), (5.0% by mass of total mix) the following Superpave properties were attained:

| MIXTURE SUMMARY | | |
|--------------------------------|---------|-------------|
| Property | Results | Criteria |
| AC (By Mass of Total Mix) (%) | 5.0 | - |
| AC (By Mass of Dry Aggre.) (%) | 5.3 | - |
| Density (kg/m ³) | 2362 | - |
| Air Voids (Va) (%) | 4.1 | 4.0 |
| VMA (%) | 14.1 | 13.0 min. |
| VFA (%) | 71.5 | 65.0 - 78.0 |
| Dust Proportion | 1.0 ✓ | 0.5 - 1.2 |
| %Gmm @ Nini | 86.4 | <89.0 |
| %Gmm @ Nmax | 97.3 | <98.0 |
| Average Dry Strength (kPa) | 360 | |
| Tensile Strength Ratio (%) | 92 | 80 Min. |
| Average Gse Blend (Gse) | 2.681 | |
| So. Gravity of Binder (Gb) | 1.030 | |
| Sp. Gravity of Aggregate (Gsb) | 2.612 | |

As indicated above, at the target asphalt content, the required mix and aggregate properties are achieved as per the criteria at a design traffic level of <3 million EASLS.

Film Thickness(µm)

10.97

The mineral aggregate properties of the combined aggregate at the job mix formula gradation (except where noted) were:

| MINERAL AGGREGATE PROPERTIES | | |
|--|--------|--------------|
| PROPERTY | RESULT | CRITERIA |
| Coarse Aggregate Angularity % Fracture by Mass (ATT 50) | 94 | 75 %, 1 Face |
| Fine Aggregate Angularity, % (TLT 125) | 43 | 40 Min. |
| Fiat and Elongated Particles (ASTM D4791) | 2.6 | 10% Max. |
| Clay Content, % (AASHTO T176) | 59 | 40 Min. |
| Toughness, % Loss* (AASHTO T96) | 18.9 | 40 Max. |
| Deleterious Material* (TLT 107) | 1.8 | 3.0 Max |

- * The reported value for Toughness (L.A. Abrasion) Loss and Deleterious Material is for the coarse aggregate fraction which represents over 70 percent of the plus 5000 μm in the combined aggregate.

The following figures and charts are attached:

- Summary of theoretical maximum specific gravity (Gmm) and asphalt absorption
- Project worksheet
- % Gmm charts for individual specimens
- Summary of mix properties vs asphalt contents
- Dust proportion worksheet
- Sieve analyses of individual aggregate proportions and the combined design aggregate

Please note that all data in the attached tables are based on percent AC by mass of total mix.

We trust the information presented is sufficient for your needs at this time. If you have any questions please contact this office.

Yours truly,

AGRA Earth & Environmental Limited

Reviewed by:



Kevin Spencer, P.Eng.
Materials Engineering Division

Dave Palsat, M.Sc., P. Eng.
Sr. Asphalt Engineer

| |
|---|
| PERMIT TO PRACTICE |
| AGRA Earth & Environmental Limited |
| Signature <u>[Signature]</u> |
| Date <u>31 OCT 95</u> |
| PERMIT NUMBER: P-4546 |
| The Association of Professional Engineers, Geologists and Geophysicists of Alberta |

The theoretical maximum specific gravity and calculated asphalt absorption was as follows:

| % AC CONTENT | | #1 | | #2 | | Avg. | |
|--------------|-----------|---------|------|---------|------|-----------|------|
| Dry Aggre. | Total Mix | Gs Max. | Abs | Gs Max. | Abs | Gs | Abs |
| 4.7 | 4.5 | 2.489 | 0.81 | 2.487 | 0.79 | 2.488 | 0.80 |
| 5.3 | 5.0 | 2.467 | 0.74 | 2.461 | 0.64 | 2.464 | 0.69 |
| 5.8 | 5.5 | 2.456 | 0.87 | 2.452 | 0.81 | 2.454 | 0.84 |
| 6.4 | 6.0 | 2.440 | 0.91 | 2.440 | 0.91 | 2.440 | 0.91 |
| | | | | | | AVG: 0.81 | |

II. ABBREVIATED COARSE AGGREGATE PETROGRAPHIC ANALYSIS

| | | | | | | | | | | | |
|---|--|--|-----------------------------|-------|---------------|--------------------------|-----|-----------------------|--------------------------------|-----|--|
| NOTATION UNITIES | CLIENT: SOUTH ROCK LTD. PROJECT NO.: CA-12139 PROJECT: HWY 3:08 | LOCATION: East Ft. Macleod Gravel Pit REPORT DATE: Sept. 12/95 REPORT TO: | | | | | | | | | |
| NO | DELETERIOUS ROCK TYPE DESCRIPTION | COMPONENTS | | | | | | | | | |
| | | COARSE | | | NATURAL FINES | | | MANUFACTURED FINES | | | |
| | | - + | - + | - + | - + | - + | - + | - + | - + | - + | |
| | | 1 1 | 1 1 | 1 | 1 1 | 1 1 | 1 | 1 1 | 1 1 | 0 5 | |
| | | 6 2 | 2 0 | 0 5 | 6 2 | 2 0 | 0 5 | 6 2 | 2 0 | 0 0 | |
| | | | 0 5 | 5 0 | 0 0 | 0 5 | 5 0 | 0 0 | 0 0 | | |
| | | | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | | |
| | | | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | | |
| | | | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | | |
| | | | 15.2 | 17.4 | 28.6 | | | | | | |
| | | | 61.2 | | | | | | | | |
| 60 | OCHREOUS MATERIALS (Iron Concretions) | | | 0.4 | | | | | | | |
| 61 | SHALE | | | 0.3 | | | | | | | |
| 63 | VOLCANIC OR SCHIST (Decomposed) | 7.6 | 11.6 | 0.6 | | | | | | | |
| 62 | CLAY (Balls or Coating) | 37.3 | 5.2 | 0.7 | | | | | | | |
| 32 | ARGILLITE-TUFF ARGILLITE-SLATE-GREYWAKE (Weathered) | | 5.9 | 2.2 | | | | | | | |
| 96 | CONCRETES (Sandy, Clayey, Sandy) | | 14.2 | 0.3 | | | | | | | |
| | SANDSTONE | | 1.5 | 4.5 | | | | | | | |
| | OTHER: Poorly cemented Sandstone Carbonate Encrustations | | | | | | | | | | |
| DELETERIOUS MATERIAL | | g | 44.9 | 37.9 | 9.1 | | | | | | |
| OTHER AGGREGATE | | g | 960.7 | 466.9 | 245.0 | | | | | | |
| TOTAL MASS (B + C) | | g | 1005.6 | 504.3 | 254.1 | | | | | | |
| % DELETERIOUS BY FRACTION (B/D) = A) | | g | 0.7 | 1.3 | 1.0 | | | | | | |
| RECOMMENDED INDIVIDUAL COMPONENT PROPORTIONS | | | | | | | | | | | |
| Blend Sand <u>1.3</u> % | | | Coarse <u>60</u> % | | | Natural Fines <u>0</u> % | | | Manufactured Fines <u>22</u> % | | |
| % Deleterious By Component Sum of "E" (F / 100) | | | <u>1.9</u> % | | | <u>0</u> % | | | <u>0</u> % | | |
| Total Deleterious Matter by Total Mass of Combined Aggregate | | | (Sum of "G") = <u>1.8</u> % | | | | | | | | |

Additional comments on possible detrimental material are to be included on an attached sheet. These comments will be under the general heading of coarse, natural fines, manufactured fines, etc. and blend sand. Each of the headings will be further divided into size fractions (eg. -16 000/+12 500). Any -5 000 material will be evaluated as having high > 7%, medium > 3% < 7%, low > 1% < 3% or trace < 1% amount of possible detrimental material.

John D. [Signature]

RA Earth & Environmental Limited
Engineering & Environmental Services

LOS ANGELES ABRASION
TEST REPORT

A CERTIFIED CONCRETE TESTING LABORATORY
IN ACCORDANCE WITH STD. A233

South Rock Limited
P.O. Box 460
Medicine Hat, AB T1A 7G2

OFFICE:
PROJECT NO.:
CLIENT:
COPIES TO:

Calgary
CA 12139
South Rock

Attn: Mr. R.W. Fortylow, P.Eng.

JECT: HWY 3:08

IRCE: East Ft. McLeod
Government Pit

SAMPLE I.D. Coarse Aggre.

SAMPLED BY: Client

TE SAMPLED:

DATE RECEIVED: Sept. 6/95

DATE TESTED: Sept. 8/95

MATERIAL GRADING: "B"

| ACTUAL SIEVE SIZES | | AMOUNT | |
|-------------------------|--------|----------------------------|----------|
| 16 mm - 12.5 mm | | 2500.5 | |
| 12.5 mm - 10 mm | | 2501.3 | |
| Q. OF REVOLUTIONS | 500 | SAMPLE | 5002.3 g |
| Q. OF SPHERES | 11 | + #12 MATERIAL AFTER | 4056.3 g |
| Q. OF SPHERES | 4586.2 | - #12 MATERIAL AFTER | 946.0 |
| LOSS AT 100 REVOLUTIONS | - % | LOSS AT 500 REVOLUTIONS | 18.3 % |
| LOSS AT 200 REVOLUTIONS | - % | LOSS AT 10 000 REVOLUTIONS | - % |

STED IN ACCORDANCE WITH ☒ CSA A23.2-16A (ASTM C131) ☐ CSA A23.2-17A (ASTM C525)

OMMENTS:

Per: 

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT



Reporting of these test results constitutes a testing service only. Engineering interpretation and discussion of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

SIEVE ANALYSIS REPORT

SOUTH ROCK LTD.
P.O. BOX 460
MEDICINE HAT ALBERTA

OFFICE: CALGARY
PROJECT NO.: CA12139
CLIENT: SOUTH ROCK LTD.

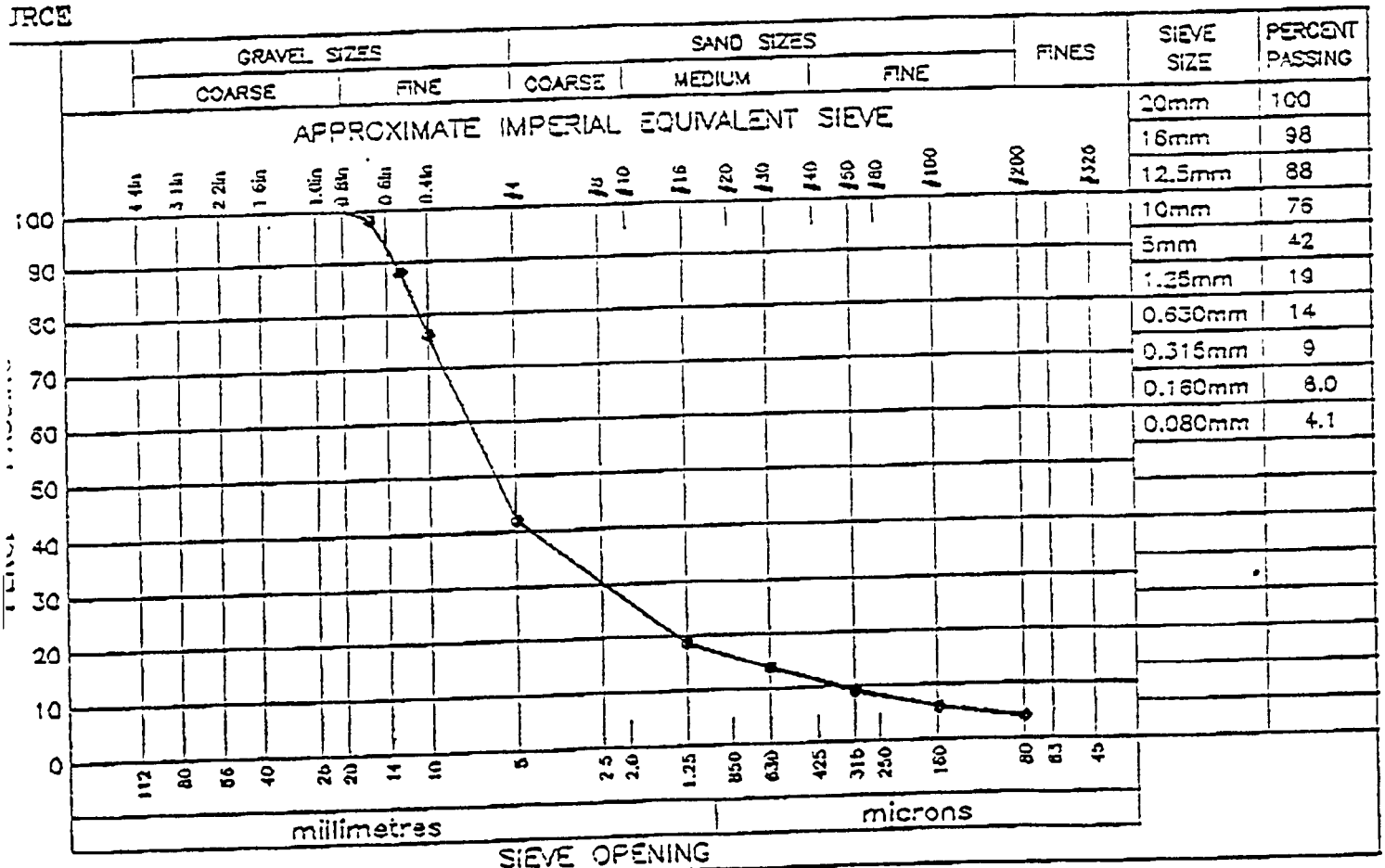
COPIES TO:

ATTN: MR. R.W.FORFYLOW P.Eng.

1430

PROJECT HIGHWAY 3-08

SAMPLE I.D. 5 SAMPLE TYPE LAB BLEND SAMPLED BY CLIENT
DATE SAMPLED DATE RECEIVED DATE TESTED 95.10.22



SAMPLE DESCRIPTION LABORATORY BLEND 65% COARSE.
2% MANUFACTURED FINES. 20% 10mm CHIP, 5% WASHED SAND
COMMENTS

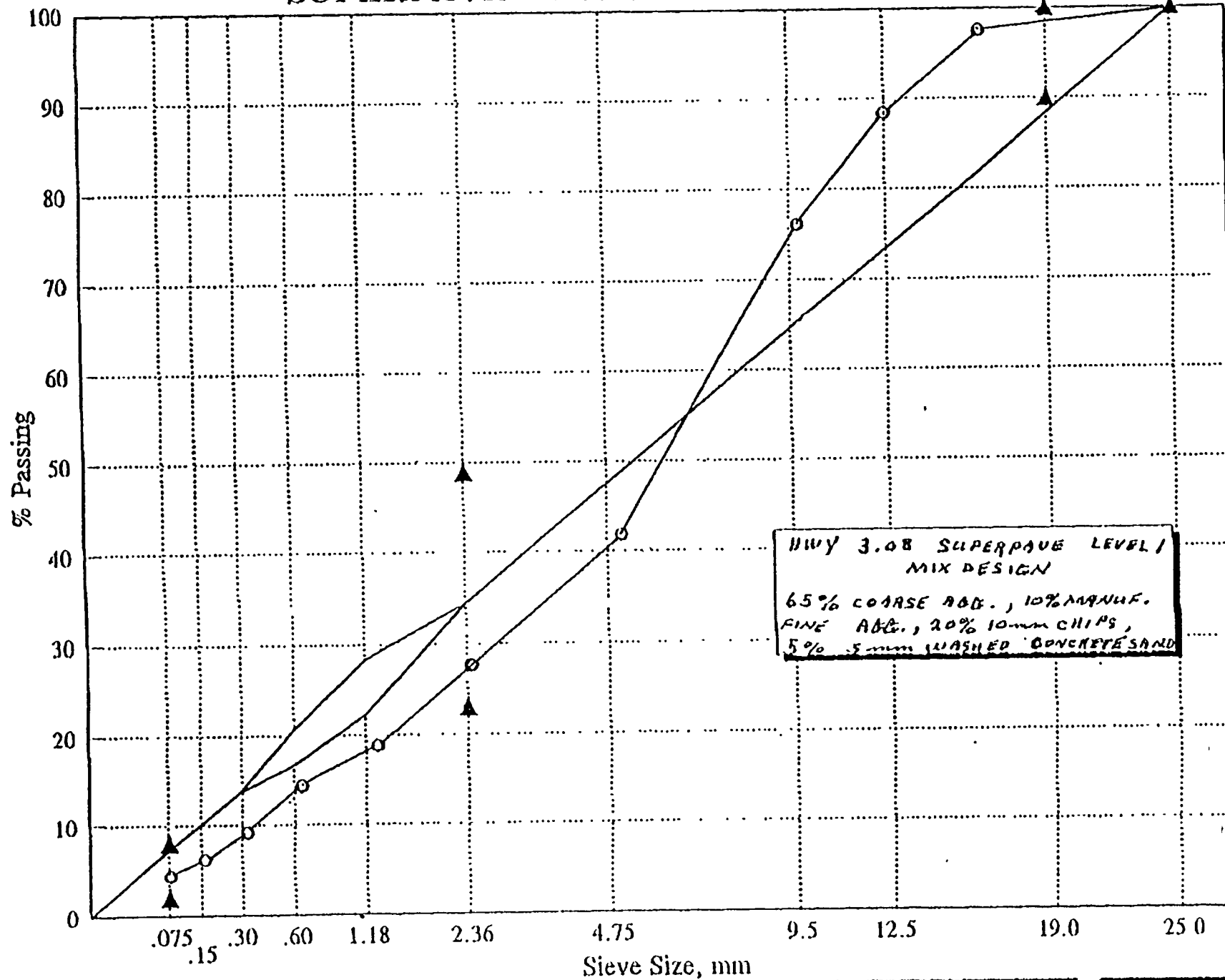
AGRA
Earth & Environmental
Limited

Per

FHWA

SUPERPAVE™ Level I TRIAL BLENDS

01A



Project Worksheet

Project Name: SOUTH ROCK HIGHWAY 3.08

Technician:

Date: 10.20.95

Design Temperature: 34 °C

Design ESAL's (millions): 2.9

Asphalt Grade: 150 200

Compaction Temp: 135 °C

Blend Identifiers

Blend 1: 4.5

Blend 2: 5.0

Blend 3: 5.5

Blend 4: 6.0

From Table VI-13

Manual Entry

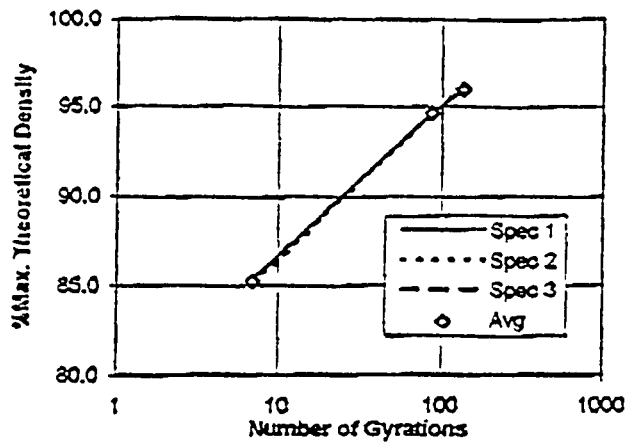
N Initial: 7 7

N Design: 86 86

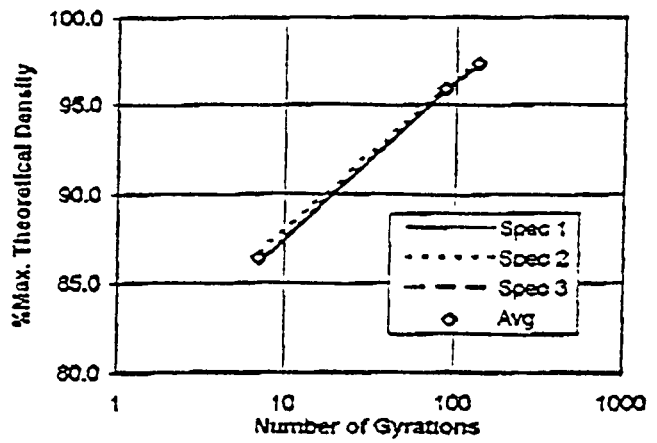
N Max: 134 134

%Gmm Charts for Individual Specimens

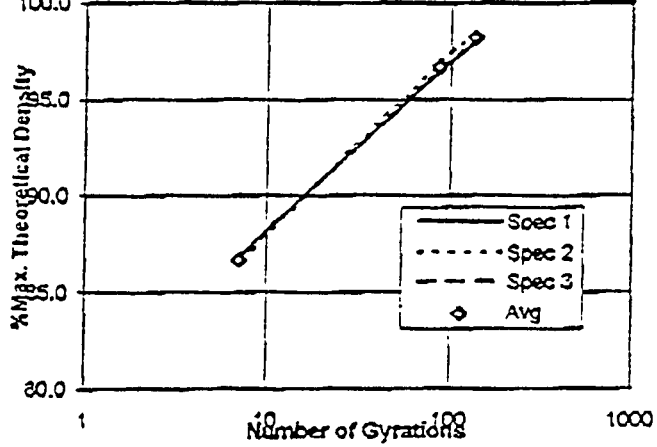
%Gmm vs. Gyration - Blend 1



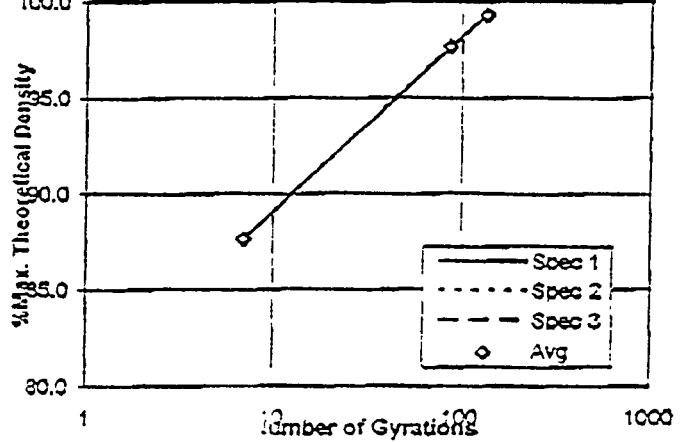
%Gmm vs. Gyration - Blend 2



%Gmm vs. Gyration - Blend 3



%Gmm vs. Gyration - Blend 4



Project Name: SOUTH ROCK HIGHWAY 3.08

Technician:

Date: 10.20.95

N Initial: 7

N Design: 86

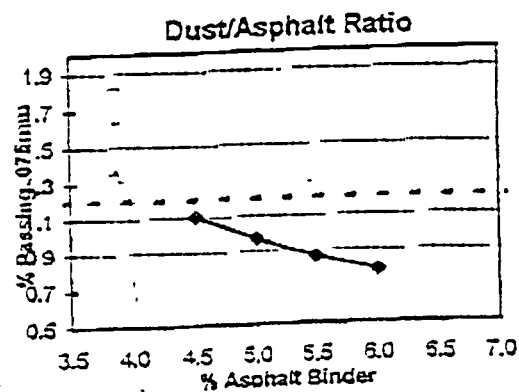
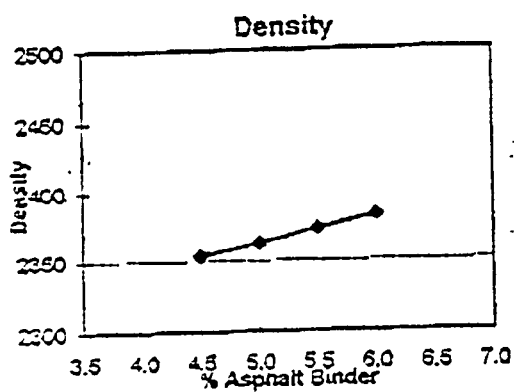
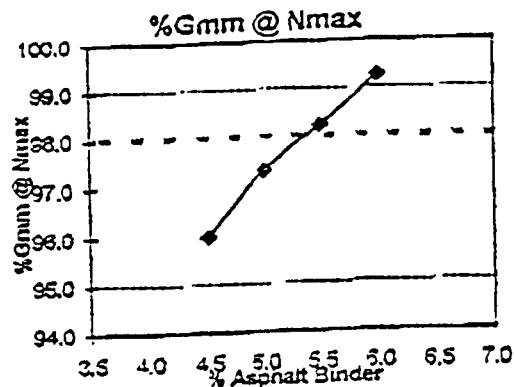
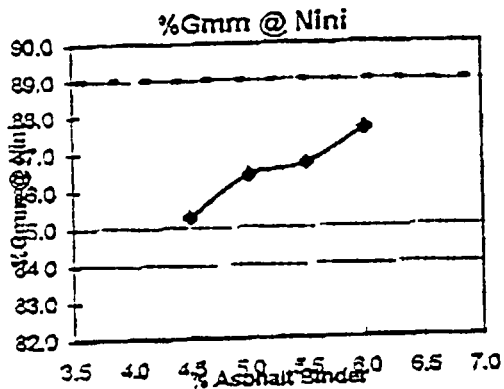
N Max: 134

Asphalt Grade: 150/200

Compaction Temp: 135 °C

Design Temperature: 34 °C

Design ESAL's (millions): 3



| Blend | %AC | %Gmm @ Ninitial | %Gmm @ NMax | Unit Wt. (kg/m³) NDesign | Dust/Asph Ratio |
|-------|-----|-----------------|-------------|--------------------------|-----------------|
| 4.5 | 4.5 | 85.3 | 96.0 | 2354 | 1.1 |
| 5 | 5.0 | 86.4 | 97.3 | 2362 | 1.0 |
| 5.5 | 5.5 | 86.7 | 98.2 | 2373 | 0.9 |
| 6 | 6.0 | 87.6 | 99.3 | 2383 | 0.8 |

by
total
wt.

Project Name: SOUTH ROCK HIGHWAY 3.08

Technician:

Date: 10.20.95

N Initial: 7

N Design: 86

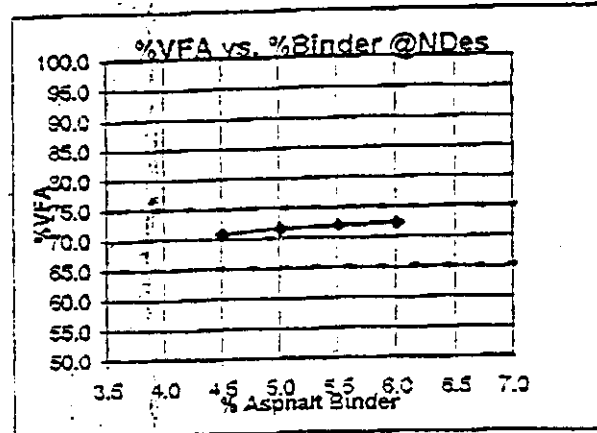
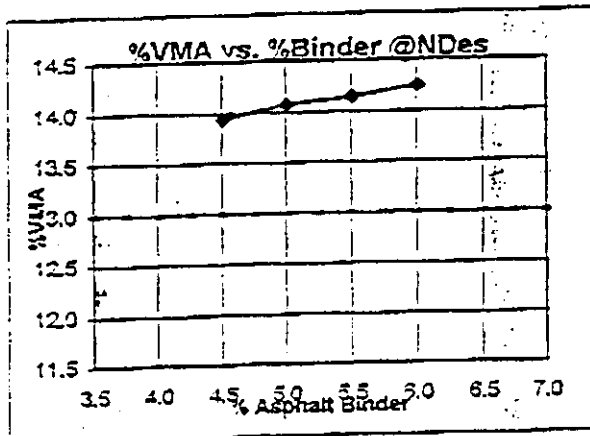
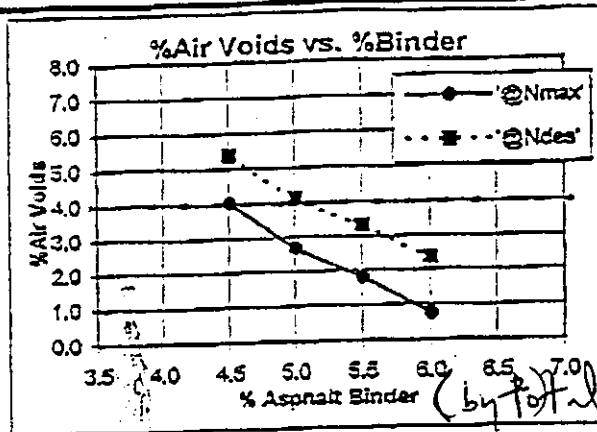
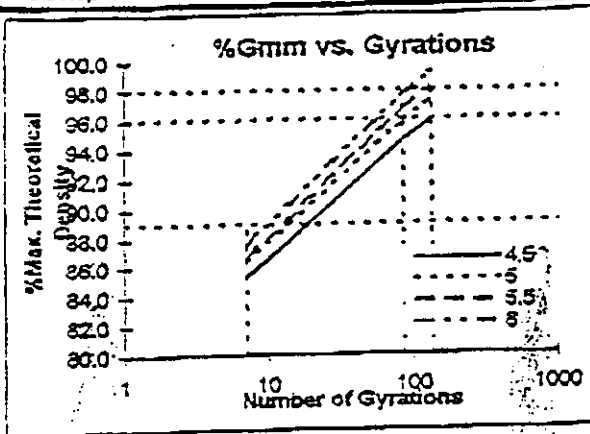
N Max: 134

Asphalt Grade: 150_200

Design Temperature: 34 °C

Compaction Temp: 135 °C

Design ESAL's (millions): 3



which blend

| Blend | %AC | Air Voids @ NMax | Air Voids @ NDesign | %VMA @NDesign | %VFA @ NDesign |
|-------|-----|---------------------|------------------------|------------------|-------------------|
| 4.5 | 4.5 | 4.0 | 5.4 | 13.9 | 70.7 |
| 5 | 5.0 | 2.7 | 4.1 | 14.1 | 71.5 |
| 5.5 | 5.5 | 1.8 | 3.3 | 14.1 | 71.9 |
| 6 | 6.0 | 0.7 | 2.3 | 14.2 | 72.2 |

| | | |
|---------------------------------------|-----------------------------|--------------|
| Project Name: SOUTH ROCK HIGHWAY 3.08 | | N Initial: 7 |
| Technician: | | N Design: 86 |
| Date: 10.20.95 | | N Max: 134 |
| Asphalt Grade: 150_200 | Design Temperature: 34 °C | |
| Compaction Temp: 135 °C | Design ESAL's (millions): 3 | |

| Blend | %AC | %Gmm @ N = 7 (corrected) | %Gmm @ N = 86 (corrected) | %Gmm @ N = 134 (corrected) | %Air Voids @ NDesign | %VMA @ NDesign |
|-------|-----|--------------------------------|---------------------------------|----------------------------------|-------------------------|-------------------|
| 4.5 | 4.5 | 85.3 | 94.6 | 96.0 | 5.4 | 13.9 |
| 5 | 5.0 | 86.4 | 95.9 | 97.3 | 4.1 | 14.1 |
| 5.5 | 5.5 | 86.7 | 96.7 | 98.2 | 3.3 | 14.1 |
| 6 | 6.0 | 87.6 | 97.7 | 99.3 | 2.3 | 14.2 |

| Blend | Estimated %AC @ 4% Va | Estimated %Gmm @ N = 7 | Estimated %Gmm @ N = 86 | Estimated %Gmm @ N = 134 | Estimated %VMA @ NDesign | Estimated %VFA @ NDesign |
|-------|-----------------------------|------------------------------|-------------------------------|--------------------------------|--------------------------------|--------------------------------|
| 4.5 | 5.1 | 86.7 | 96.0 | 97.4 | 13.7 | 70.7 |
| 5 | 5.0 | 86.5 | 96.0 | 97.4 | 14.1 | 71.5 |
| 5.5 | 5.2 | 86.0 | 96.0 | 97.5 | 14.2 | 71.9 |
| 6 | 5.3 | 86.0 | 96.0 | 97.5 | 14.4 | 72.2 |

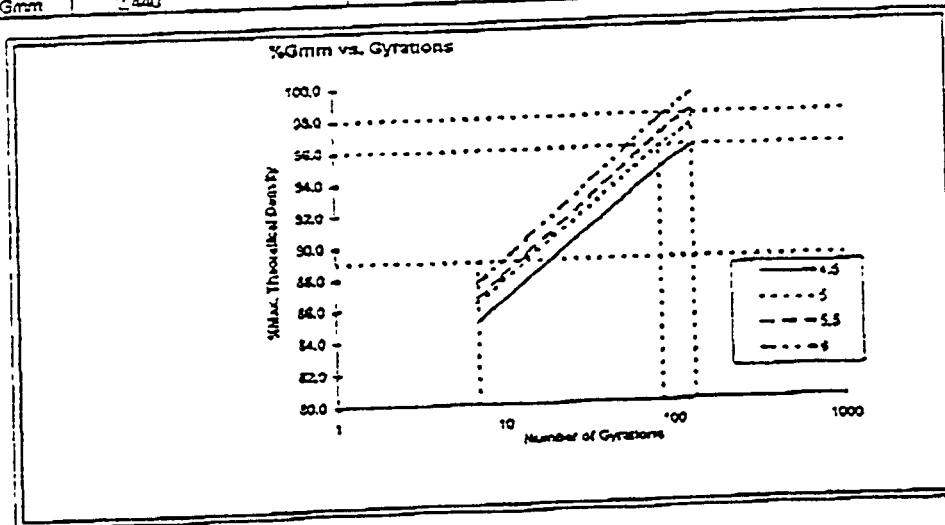
| | |
|--------------------------------------|-----------------------------|
| Project Name: SOUTH ROCK HIGHWAY 303 | N Test: 7 |
| Technician: | N Design: 88 |
| Date: 10.20.96 | N Max: 134 |
| Asphalt Grade: 150_200 | Design Temperature: 34 °C |
| Compact Temp: 135 °C | Design ESAL's (millions): 3 |

| 4.5 | | | | | | | | | | Avg. |
|------|------------|----------------|---------------|------------|----------------|---------------|------------|----------------|---------------|------|
| #Gyr | Specimen 1 | | | Specimen 2 | | | Specimen 3 | | | |
| | HL (mm) | %Gmm (Est.) | %Gmm (Com) | HL (mm) | %Gmm (Est.) | %Gmm (Com) | HL (mm) | %Gmm (Est.) | %Gmm (Com) | |
| 7 | 122.0 | 0.0 | 85.4 | 131.5 | 0.0 | 85.1 | | | | 85.2 |
| 88 | 119.2 | 0.0 | 84.8 | 113.3 | 0.0 | 94.6 | | | | 94.8 |
| 124 | 117.5 | 0.0 | 96.0 | 118.6 | 0.0 | 96.0 | | | | 96.0 |
| Gmb | 2.338 | | | 2.338 | | | | | | |
| Gmm | 2.488 | | | | | | | | | |

| 5 | | | | | | | | | | Avg. |
|------|------------|----------------|---------------|------------|----------------|---------------|------------|----------------|---------------|------|
| #Gyr | Specimen 1 | | | Specimen 2 | | | Specimen 3 | | | |
| | nL (mm) | %Gmm (Est.) | %Gmm (Com) | nL (mm) | %Gmm (Est.) | %Gmm (Com) | nL (mm) | %Gmm (Est.) | %Gmm (Com) | |
| 7 | 132.9 | 0.0 | 85.1 | 129.2 | 0.0 | 86.7 | | | | 86.4 |
| 88 | 113.4 | 0.0 | 95.8 | 116.7 | 0.0 | 96.0 | | | | 95.9 |
| 124 | 117.5 | 0.0 | 97.2 | 115.0 | 0.0 | 97.4 | | | | 97.3 |
| Gmb | 2.296 | | | 2.400 | | | | | | |
| Gmm | 2.484 | | | | | | | | | |

| 55 | | Specimen 1 | | | Specimen 2 | | | Specimen 3 | | | Avg. |
|------|-------|------------|-------|-------|------------|-------|------|------------|-------|------|------|
| #Gyr | HL | %Gmm | %Gmm | HL | %Gmm | %Gmm | HL | %Gmm | %Gmm | | |
| | (mm) | (Est.) | (Com) | (mm) | (Est.) | (Com) | (mm) | (Est.) | (Com) | | |
| 7 | 131.9 | 0.0 | 86.8 | 133.0 | 0.0 | 86.8 | | | | 86.7 | |
| 86 | 118.7 | 0.0 | 96.5 | 118.8 | 0.0 | 96.9 | | | | 96.7 | |
| 134 | 115.9 | 0.0 | 98.0 | 116.9 | 0.0 | 98.5 | | | | 98.2 | |
| Gmb | 2.404 | | | 2.417 | | | | | | | |
| Gmm | 2.454 | | | | | | | | | | |

| 5 | | | | | | | | | | |
|------|------------|--------|-------|------------|--------|-------|------------|--------|-------|------|
| #Gyr | Specimen 1 | | | Specimen 2 | | | Specimen 3 | | | Avg. |
| | HL | %Gmm | %Gmm | HL | %Gmm | %Gmm | HL | %Gmm | %Gmm | |
| | (mm) | (Est.) | (Com) | (mm) | (Est.) | (Com) | (mm) | (Est.) | (Com) | |
| 7 | 131.1 | 0.0 | 87.5 | 131.1 | 0.0 | 87.5 | | | | 87.5 |
| 96 | 117.7 | 0.0 | 97.5 | 117.5 | 0.0 | 97.7 | | | | 97.7 |
| 124 | 115.7 | 0.0 | 99.3 | 115.8 | 0.0 | 99.2 | | | | 99.3 |
| Gms | 2.422 | | | 2.421 | | | | | | |
| Gmm | 2.440 | | | | | | | | | |



Dust Proportion (Fines/Pbe) Worksheet

| | Inputs | | | |
|----------------------------------|---------|---------|---------|---------|
| | Blend 1 | Blend 2 | Blend 3 | Blend 4 |
| Absorbion Constant | 0.8 | 0.8 | 0.8 | 0.8 |
| Apparent Specific Gravity (Gsa): | 2.681 | 2.681 | 2.681 | 2.681 |
| Specific Gravity of Binder (Gb): | 1.030 | 1.030 | 1.030 | 1.030 |
| Fines (% Passing .075mm Sieve) | 4.1 | 4.1 | 4.1 | 4.1 |

| | Outputs | | | |
|----------------------------------|---------|-------|-------|-------|
| Percent AC (Pbi) | 4.5 | 5.0 | 5.5 | 6.0 |
| Effective Specific Gravity (Gse) | 2.667 | 2.667 | 2.667 | 2.667 |
| Effective % Binder (Pbe) | 3.7 | 4.2 | 4.7 | 5.2 |
| Dust Proportion (Fines/Pbe) | 1.1 | 1.0 | 0.9 | 0.8 |

Trial Asphalt Binder Content (%AC) Worksheet

| | 4.5 | 5 | 5.5 | 6 |
|--|-------|-------|-------|-------|
| Aggregate Bulk Specific Gravity (Gsb): | 2.612 | 2.612 | 2.612 | 2.612 |
| Percent Binder by wt. of mix (Pb): | 4.5 | 5.0 | 5.5 | 6.0 |
| Percent Aggregate (Ps): | 95.5 | 95.0 | 94.5 | 94.0 |

 **AGRA**
Earth & Environmental

CA-12165
25 October 1995

South Rock Limited
P.O. Box 460
Medicine Hat, Alberta
T1A 7G2

Attention: Mr. R.W. Fortylow, P. Eng.

Dear Sir:

RE: HIGHWAY 3:08
CONTRACT #5519/94

As per your request, AGRA Earth & Environmental Limited (AEE) has performed a Marshall mix design in accordance with Alberta Transportation and Utilities specifications for Designation 1 Class 16, Type 2 Asphalt Concrete Mix.

The average submitted stockpile gradations of the coarse aggregate, manufactured fines, and two blend sand sources are presented as Sample No. 1 through No. 4, attached. Based upon the average stockpile gradations, the mix aggregates were blended as follows, as specified by South Rock:

| | |
|----|---|
| 60 | percent coarse aggregate |
| 22 | percent manufactured fines |
| 9 | percent blend sand, Ft. McLeod East Pit |
| 9 | percent blend sand, McCollough Pit |

The results of this combined grading are presented in the attached sieve analysis identified as Sample No. 5, Lab Blend.

Preparation of the asphalt mix samples was in accordance with the Marshall Method of Mix Design as outlined in the latest edition of the Asphalt Institute Manual Series No. 2 (MS-2) and ASTM D1559 (75 Blow) incorporating Husky 150/200A penetration grade asphalt cement and aggregates combined as noted above.

A summary of the Marshall mix analyses are presented graphically and in Table No. 1, attached.

At an asphalt binder content of 5.5 percent (by mass of dry aggregate), the following Marshall properties were attained:

| Marshall Property | Mix Design Results | Specifications |
|----------------------------------|--------------------|----------------|
| A.C. Content (% dry wt. agg.) | 5.5 | - |
| Density (kg/m ³) | 2368 | - |
| Marshall Stability (kN) | 15.8 | 12.0 min. |
| Flow (mm) | 2.9 | 2.0 to 3.5 |
| Air Void (%) | 3.9 | 3 to 5 |
| V.M.A. (%) | 14.2 | 13.5 |
| Film Thickness (μm) | 6.9 ✓ | - |
| Voids Filled (%) | 73 | 65 - 75 % |
| Retained Stability (%) | 96 | 70 min. |

F/A ratio 1.5

Please note that at the target asphalt cement content (5.5% by mass of dry aggregate) compliance with the specifications was achieved.

Included in Table No. 1 are the reported test results for; the mixing and compaction temperatures, the aggregate bulk relative density, asphalt cement relative density and the asphalt absorption.

The theoretical maximum specific gravity of the paving mixture was as follows:

| A.C. Concrete % (Dry Weight) | M.T.D. | | | | | |
|---------------------------------|----------------------|-------------|----------------------|-------------|--------------------------------|-------------|
| | #1 <u>Gs max.</u> | <u>abs.</u> | #2 <u>Gs max.</u> | <u>abs.</u> | Avg. <u>Gs.</u> <u>abs.</u> | |
| 5.2 | 2.468 | 0.65 | 2.478 | 0.84 | 2.473 | 0.75 |
| 5.5 | 2.466 | 0.79 | 2.462 | 0.72 | 2.464 | 0.75 |
| 5.7 | 2.455 | 0.70 | 2.460 | 0.79 | 2.458 | 0.75 |
| | | | | | AVG. | <u>0.75</u> |

Pertinent data related to aggregate quality is summarized below and included in the attachments:

- Percent fracture (2 faces) on the plus 5000 μ m portion of the recombined aggregate blend was determined to be 94%, exceeding the specified minimum of 70%.
- The Percentage of Manufactured Fines in the -5000 portion of the combined aggregate are calculated at 70.4%, exceeding the specified minimum of 70%.
- The Los Angeles Abrasion test on a sample of coarse aggregate was determined to be 18.9% loss, meeting the requirement of 40% maximum loss.
- The Plasticity Index of the aggregate material produced was determined to be non-plastic.
- An abbreviated petrographic analysis was performed on a sample of the coarse aggregate; the detrimental matter was determined to be 1.8%, meeting the requirement of 3.0% maximum.

As indicated above, at the target asphalt content, the required mix and aggregate properties are achieved. Experience has indicated that the properties of plant produced hot mix may vary from mix properties obtained with laboratory prepared hot mix samples. This may result in an increase in Marshall density causing a reduction in VMA and air voids content. Initial plant production should be closely monitored to confirm mix design properties and to make necessary adjustments to the target asphalt content and/or aggregate proportions. Significant changes may require additional mix design testing.

TABLE NO. 1
SUMMARY OF MARSHALL PROPERTIES
HIGHWAY 3:08

| Binder Content % by Mass of Agg. Total | | Density kg/m ³ | Marshall Stability kN | Retained Stability % | Flow mm | VMA % | Air Voids % | Voids Filled % |
|--|-----|------------------------------|-----------------------------|----------------------------|------------|----------|----------------|----------------------|
| 4.7 | 4.5 | 2338 | 14.8 | - | 2.4 | 14.7 | 6.1 | 59 |
| 5.2 | 4.9 | 2361 | 16.4 | - | 2.7 | 14.2 | 4.6 | 68 |
| 5.5 | 5.2 | 2368 | 15.8 | 96 | 2.9 | 14.2 | 3.9 | 73 |
| 5.7 | 5.4 | 2377 | 15.6 | - | 3.1 | 14.1 | 3.3 | 77 |
| 6.2 | 6.8 | 2383 | 15.3 | - | 3.4 | 14.3 | 2.4 | 83 |

Mixing Temperature: 145°C
 Compaction Temp.: 135 °C
 Blows/Face (Manual) 75

Aggregate Bulk Relative Density: 2.617
 Binder Relative Density: 1.03
 Binder Absorption, % 0.75

Aggregate: See Attached Sieve Analysis

TO: SOUTH ROCK LTD.
P.O. BOX 460
MEDICINE HAT ALBERTA

OFFICE: CALGARY
PROJECT NO.: CA12165
CLIENT: SOUTH ROCK LTD.

COPIES TO:

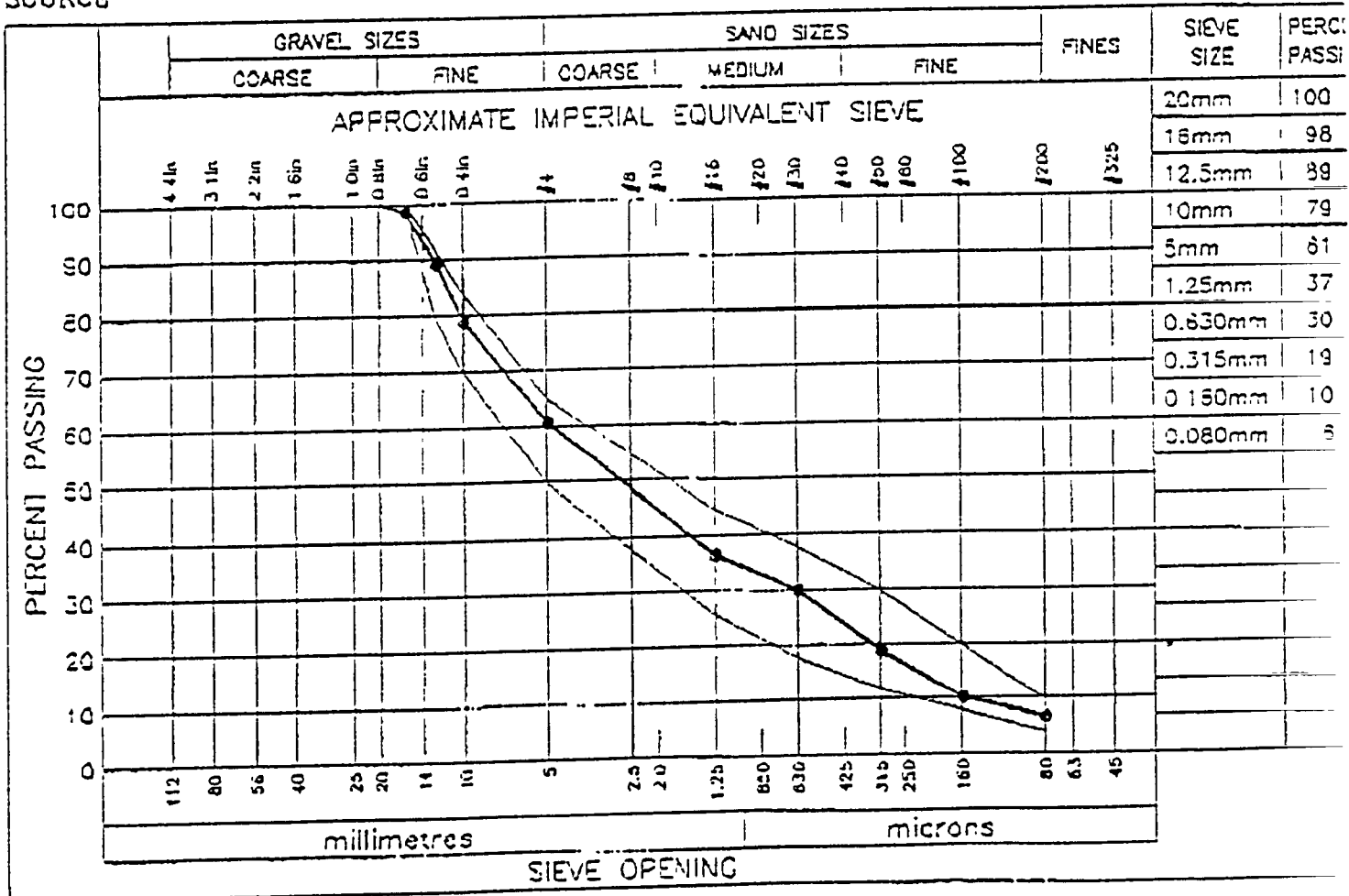
ATTN: MR. R.W.FORFYLOW P.Eng.

PROJECT HIGHWAY 3:08

14

SAMPLE I.D. 5 SAMPLE TYPE LAB BLEND (60/22/9/9) SAMPLED BY CLIENT
DATE SAMPLED DATE RECEIVED DATE TESTED 95.10.22

SOURCE



SAMPLE DESCRIPTION LABORATORY BLEND

COMMENTS 60% COARSE. 22% MANUFACTURED FINES. 9% BLEND
SAND #1, 9% BLEND SAND #2 (McCOLLOUGH)
PERCENT CRUSH (PLUS 5mm MATERIAL, 2 FACES) 94%

AGRA
Earth & Environmental
Limited

Per *[Signature]*

SIEVE ANALYSIS REPORT

TO: SOUTH ROCK LTD.
P.O. BOX 460
MEDICINE HAT ALBERTA

ATTN: MR. R.W.FORFYLOW P.Eng.

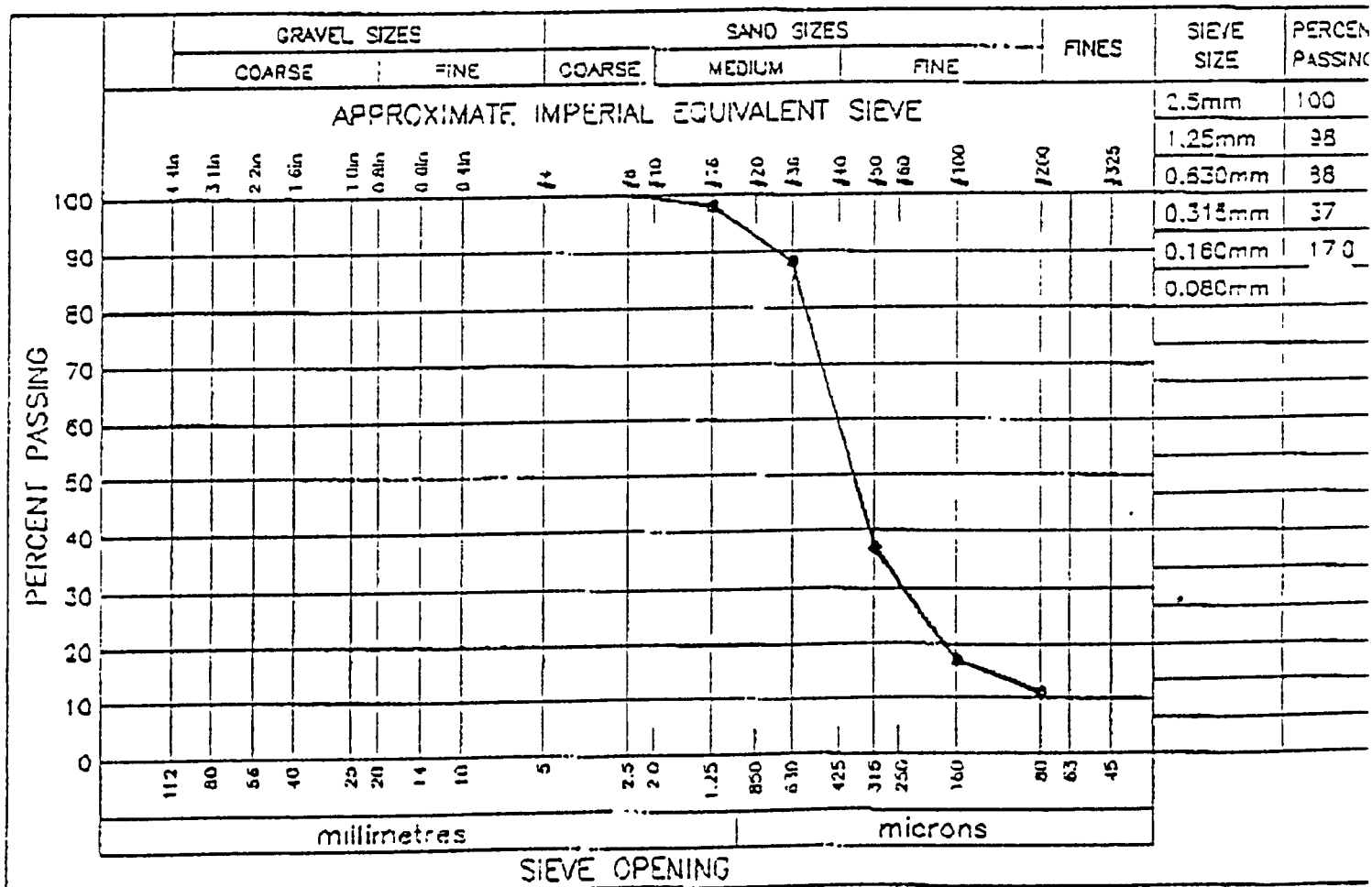
OFFICE: CALGARY -
PROJECT NO.: CA12165
CLIENT: SOUTH ROCK LTD.

COPIES TO:

PROJECT HIGHWAY 3:08

1423

| | | | | | | |
|--------------|---|---------------|------------|----|-------------|----------|
| SAMPLE I.D. | 3 | SAMPLE TYPE | BLEND SANC | #1 | SAMPLED BY | CUENT |
| DATE SAMPLED | | DATE RECEIVED | | | DATE TESTED | 95.10.22 |
| SOURCE | EAST FT. McLEOD GOVERNMENT PIT, SW7-9-25-W4 | | | | | |



SAMPLE DESCRIPTION BLEND SAND # 1

COMMENTS

AGRA
Earth & Environment
Limited

Per

APPENDIX B

DETAILED CONSTRUCTION NOTES

DETAILED CONSTRUCTION NOTES

| | |
|--|--|
| SECTION: <u>81A901</u> LANE: <u>Travel</u> PAVING WIDTH: <u>7.2 meters</u> Weather Conditions: <u>Cold, Cloudy and Breezy</u> | DATE: <u>November 22, 1995</u> LIFT: <u>Bottom (#1)</u> TIMES: START. <u>7:45 a.m.</u> END. <u>9.50 a.m.</u> |
|--|--|

| Construction Station | Uncompacted Thickness (mm) | Mat Temperature (°C) | Comments |
|----------------------|----------------------------|----------------------|--|
| 14+520 | 82 | 125 | Air Temp = -3c - Surface tacked prior to placement |
| 14+555 | 75 | 148 | Mix is much finer than superpave mixes. |
| 14+570 | 75 | 155 | Mix looks drier than superpave but not too dry. |
| 14+585 | 85 | 153 | |
| 14+600 | 80 | 155 | |
| 14+615 | 80 | 150 | |
| 14+660 | 77 | 157 | |
| 14+675 | 80 | 158 | |
| 14+690 | 70 | 150 | |
| 14+705 | 77 | 155 | |
| 14+720 | 85 | 153 | Samples taken by ATU and contractor |
| 14+735 | 77 | 152 | 8:25 a.m. - Snow flurries |
| 14+750 | 75 | 150 | |
| 14+765 | 77 | 160 | |
| 14+780 | 77 | 148 | |
| 14+795 | 78 | 156 | |
| 14+810 | 75 | 156 | |
| 14+825 | 80 | 156 | Paver stopped for 5 min. - waiting on trucks |
| 14+840 | 77 | 151 | |
| 14+855 | 75 | 144 | Paver stopped for 2 min. - waiting on trucks |
| 14+880 | 78 | 148 | Paver stopped for 5 min. - waiting on trucks |
| 14+910 | 75 | 140 | Paver stopped for 15 min. - waiting on trucks |
| 14+940 | 70 | 135 | Paver stopped for 8 min. - waiting on trucks |
| 14+965 | 70 | 144 | |
| 14+980 | 70 | 139 | Air Temp = -1c |
| Average | 76.8 | 149.5 | |
| Std Dev | 4.1 | 8.1 | |

DETAILED CONSTRUCTION NOTES

| | |
|---|--|
| SECTION: <u>81A901</u> LANE: <u>Travel</u> PAVING WIDTH: <u>7.1meters</u> Weather Conditions: <u>Cold, Cloudy and Breezy</u> | DATE: <u>November 22, 1995</u> LIFT: <u>Top (#2)</u> TIMES: START: <u>10 35 a m</u> END: <u>12.05 p.m.</u> |
|---|--|

| Construction Station | Uncompacted Thickness (mm) | Mat Temperature (°C) | Comments |
|----------------------|----------------------------|----------------------|--|
| 14+515 | 80 | 131 | Air Temp = -1c - Surface tacked prior to placement |
| 14+550 | 70 | 136 | |
| 14+575 | 68 | 129 | |
| 14+600 | 80 | 130 | |
| 14+640 | 80 | 136 | |
| 14+675 | 82 | 144 | |
| 14+690 | 80 | 141 | Slight segregation in mat - fixed by hand |
| 14+705 | 80 | 138 | |
| 14+720 | 85 | 138 | |
| 14+735 | 77 | 126 | |
| 14+750 | 80 | 142 | Samples collected by ATU |
| 14+765 | 85 | 140 | |
| 14+780 | | | Paver stopped for 7 min.- waiting on trucks |
| 14+795 | 80 | 142 | Four rollers being used |
| 14+810 | 80 | 135 | Finish roller is vibrating and surface temp is 89c |
| 14+825 | 83 | 132 | |
| 14+840 | 83 | 143 | |
| 14+855 | 80 | 142 | |
| 14+890 | 80 | 144 | |
| 14+920 | 80 | 142 | |
| 14+950 | 73 | 142 | Large area of segregation in middle of mat - |
| 14+970 | 75 | 141 | repaired by hand. |
| 14+985 | 72 | 132 | Air Temp = 0c |
| Average | 78.8 | 137.5 | |
| Std Dev | 4.5 | 5.4 | |

DETAILED CONSTRUCTION NOTES

| | |
|--|--|
| SECTION: <u>81A902</u> LANE: <u>Travel</u> PAVING WIDTH: <u>7.2 meters</u> Weather Conditions: <u>Clear and Sunny</u> | DATE: <u>November 21, 1995</u> LIFT: <u>Bottom (#1)</u> TIMES: START: <u>7:45 a.m.</u> END: <u>9:30 a.m.</u> |
|--|--|

| Construction Station | Uncompacted Thickness (mm) | Mat Temperature (°C) | Comments |
|----------------------|----------------------------|----------------------|---|
| 13+700 | 75 | 135 | Air Temperature = 5c |
| 13+750 | 70 | 128 | Paver stopped - Breakdown for ~ 40 min. |
| 13+780 | 75 | 123 | |
| 13+795 | 70 | 121 | |
| 13+810 | 70 | 126 | |
| 13+825 | 67 | 126 | Contractor collecting samples |
| 13+840 | 70 | 127 | |
| 13+855 | 70 | 134 | |
| 13+870 | 73 | 128 | Temperature inside mat = 142c |
| 13+895 | 80 | 113 | |
| 13+920 | 70 | 110 | Paver stopped for ~ 10 min - waiting for trucks |
| 13+950 | 75 | 101 | |
| 13+975 | 80 | 109 | |
| 14+000 | 75 | 104 | Cleaned out paver at stn 14+000 |
| Average | 72.9 | 120.4 | |
| Std Dev | 4 0 | 11 0 | |

DETAILED CONSTRUCTION NOTES

| | | | |
|---------------------|---------------|--------|-------------------|
| SECTION: | 81A902 | DATE | November 21, 1995 |
| LANE: | Travel | LIFT: | Top (#2) |
| PAVING WIDTH: | 7.1 meters | TIMES: | |
| | | START: | 5 25 p.m |
| | | END: | 6.50 p.m. |
| Weather Conditions: | Cool and Dark | | |

| Construction Station | Uncompacted Thickness (mm) | Mat Temperature (°C) | Comments |
|----------------------|----------------------------|----------------------|--|
| 13+520 | 134 | 75 | Air temp = 1c, Paving joint offset right 75mm |
| 13+535 | 136 | 70 | |
| 13+550 | 136 | 80 | |
| 13+575 | 135 | 77 | |
| 13+600 | 131 | 70 | 120c during breakdown rolling, 129c in mat |
| 13+650 | 133 | 75 | Intermediate roller directly behind breakdown roller |
| 13+675 | 137 | 70 | |
| 13+690 | 132 | 75 | |
| 13+705 | 141 | 75 | |
| 13+720 | 138 | 75 | |
| 13+735 | 135 | 75 | |
| 13+750 | 136 | 75 | |
| 13+765 | 136 | 77 | Temperature in mat behind paver is 138c |
| 13+780 | 136 | 77 | |
| 13+795 | 136 | 75 | |
| 13+810 | 130 | 75 | |
| 13+825 | 136 | 73 | |
| 13+840 | 135 | 78 | |
| 13+855 | 141 | 75 | |
| 13+870 | 136 | 75 | |
| 13+895 | 137 | 80 | |
| 13+920 | 138 | 80 | |
| 13+950 | 136 | 72 | |
| 13+975 | 137 | 85 | Air temp = -1c |
| Average | 135.8 | 75.6 | |
| Std Dev | 2.6 | 3.5 | |

DETAILED CONSTRUCTION NOTES

| | |
|---|---|
| SECTION: <u>81A903</u> LANE: <u>Travel</u> PAVING WIDTH: <u>7.2 meters</u> Weather Conditions: <u>Cool and Partly Cloudy</u> | DATE: <u>November 21, 1995</u> LIFT: <u>Bottom (#1)</u> TIMES. START: <u>11:27 a.m.</u> END: <u>1:15 p.m.</u> |
|---|---|

| Construction Station | Uncompacted Thickness (mm) | Mat Temperature (°C) | Comments |
|----------------------|----------------------------|----------------------|--|
| 14+060 | 70 | 110 | Air Temp = 9c |
| 14+075 | 73 | 126 | |
| 14+090 | 75 | 116 | |
| 14+105 | 70 | 111 | |
| 14+120 | 70 | 117 | |
| 14+135 | 75 | 123 | |
| 14+150 | 80 | 125 | Numerous samples - ATU, EBA, AGRA & contractor |
| 14+175 | 90 | 124 | |
| 14+190 | 87 | 133 | |
| 14+205 | 95 | 138 | |
| 14+220 | 85 | 138 | |
| 14+235 | 75 | 133 | |
| 14+250 | 75 | 135 | |
| 14+265 | 75 | 125 | |
| 14+280 | 78 | 123 | |
| 14+295 | 85 | 119 | |
| 14+310 | 81 | 115 | |
| 14+325 | 75 | 124 | |
| 14+340 | 85 | 123 | Mat temp = 134c |
| 14+355 | 80 | 128 | Paver stopped for 5 min. - waiting on trucks |
| 14+385 | 75 | 128 | Paver stopped for 3 min. - waiting on trucks |
| 14+400 | 80 | 124 | |
| 14+420 | 80 | 126 | |
| 14+440 | 82 | | Paver stopped for 7 min. - waiting on trucks - No temp |
| 14+460 | 85 | 114 | |
| 14+480 | 80 | 121 | |
| 14+500 | 80 | 121 | |
| Average | 79.3 | 123.8 | |
| Std Dev | 6.2 | 7.5 | |

DETAILED CONSTRUCTION NOTES

SECTION: 81A903

DATE: November 21, 1995

LANE: Travel

LIFT: Top (#1)

PAVING
WIDTH: 7.1meters

TIMES:
START: 2:00 p.m.
END: 3:15 p.m.

Weather
Conditions: Cool and Cloudy

| Construction Station | Uncompacted Thickness (mm) | Mat Temperature (°C) | Comments |
|----------------------|----------------------------|----------------------|-------------------------------------|
| 14+060 | 72 | 114 | Air Temp = 8c |
| 14+075 | 80 | 114 | |
| 14+090 | 75 | 113 | |
| 14+105 | 75 | 125 | Paver slipping - pulled with blade |
| 14+120 | 70 | 121 | |
| 14+135 | 80 | 124 | |
| 14+150 | 75 | 118 | |
| 14+175 | 75 | 119 | |
| 14+190 | 77 | 125 | |
| 14+205 | 75 | 118 | |
| 14+220 | 80 | 126 | |
| 14+235 | 75 | 126 | |
| 14+250 | 75 | 127 | |
| 14+265 | 77 | 124 | |
| 14+280 | 75 | 125 | |
| 14+295 | 75 | 123 | |
| 14+310 | 75 | 123 | |
| 14+325 | 70 | 122 | |
| 14+340 | 75 | 126 | |
| 14+355 | 80 | 119 | |
| 14+385 | 75 | 120 | |
| 14+400 | 75 | 125 | Paver slipping - stopped for 2 min. |
| 14+420 | 80 | 130 | |
| 14+440 | 75 | 126 | |
| 14+460 | 80 | 126 | |
| 14+480 | 80 | 128 | |
| 14+500 | 70 | 120 | Air Temp = 6c |
| Average | 75.8 | 122.5 | |
| Std Dev | 3.1 | 4.4 | |